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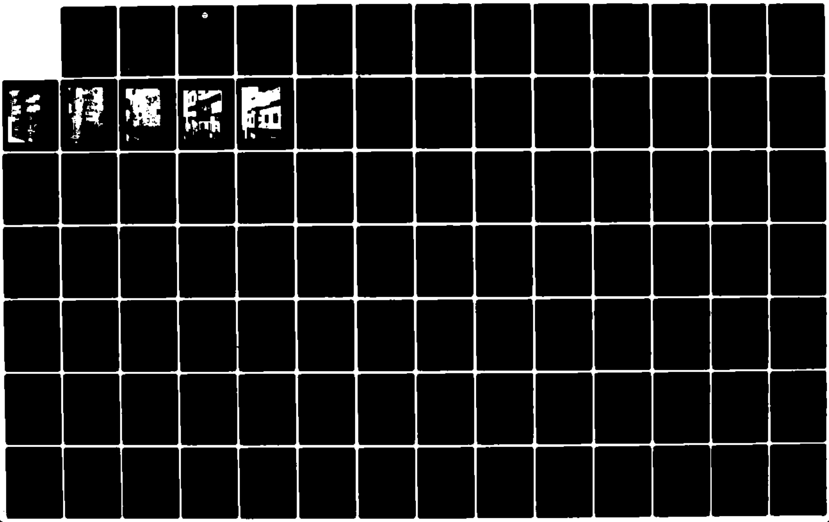

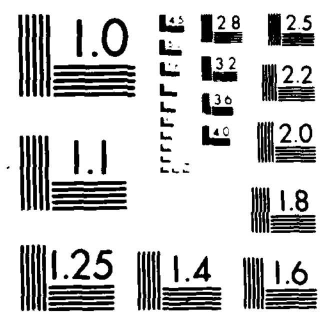

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KLYSTRON MANUFACTURING TECHNOLOGY PROGRAM

Varian Microwave Tube Division

September 1983

Prepared for
Naval Electronic Systems Command
Code 81341

NOSC

NAVAL OCEAN SYSTEMS CENTER
San Diego, California 92152

NAVAL OCEAN SYSTEMS CENTER SAN DIEGO, CA 92152

AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

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ADMINISTRATIVE INFORMATION

This task was performed for Naval Electronic Systems Command, Code 81341, Washington, DC 20360 under program element OPN ET14. Contract N00123-81-C-0245 was carried out by Varian Microwave Tube Division, 611 Hansen Way, Palo Alto, CA 94303 under the direction of Junn Troy and Wilbur Watson, Naval Ocean Systems Center (NOSC Code 553), San Diego, CA 92152.

Acknowledgement for their work and cooperation is given to Edwin Rowe, Michael Mahoney, Earl Hampton, Walter Nelson, Russell Scott, and Frank Percell of the Varian Microwave Tube Division, and to George Stanley and David Shaw of General Dynamics, Pomona Division.

Released by
W. H. Watson, Head
Microwave Technology Group

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Brazing	Production	Cost reduction
Self-jigging	Klystron-VKU-7785F	Manufacturing technology
Repairability	Numerically-controlled	Phalanx klystrons

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The objective of the MT program is to demonstrate improved production techniques by a small production run of three (3) tubes to meet performance specification and system compatibility criteria under production line conditions.

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SUMMARY

A number of potential manufacturing technology improvements were identified and investigated for incorporation into the klystron amplifier. Some of these were discarded because they were not feasible or did not result in sufficient reduction of cost, improved manufacturing processes or yield factor.

The principal areas of effort were: the use of:

1. Investment castings
2. Steel forgings
3. Punch press parts
4. Material changes
5. Consolidation or elimination of parts and assembly operations
6. Simplification of braze procedures
7. Reduction of the number of brazes and machining steps between operations
8. Use of fixturing and special tooling together with numerical control machining
9. Reducing the skill level required to manufacture a complex device
10. State of the art processing such as hobbing, cold forming and sintering.

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1. INTRODUCTION

This report covers the Manufacturing Technology (MT) Program conducted at the Varian Microwave Tube Division, Palo Alto, California, sponsored by the Department of the Navy in an effort to improve and reduce costs for the high power klystron and autotuner unit used on a major weapon system.

This program was proposed to introduce simpler and improved techniques and processes toward a more reliable and cost effective method to manufacture klystrons. The proposed changes were introduced into the VKU-7785F klystron.

The three high power klystrons fabricated with these changes have successfully passed the Naval Sea Systems Command Acceptance Test Procedures for the power klystron. One of these three high power klystrons was selected to undergo further testing in accordance with the Periodic Conformance Inspection Test Procedures used on the current production program for the VKU-7785E model high power klystrons. The klystron has passed this final test and meets all the current model specifications.

The improved version of processes and methods is intended to be incorporated into future Phalanx klystrons after the VKU-7785F high power klystron has been proven in the system application at General Dynamics, Pomona Division.

This report describes the present techniques, processes, and methodology used on the current production tube, VKU-7785E, and the new methods and techniques used to improve and reduce the cost of manufacture on the VKU-7785F, MT model.

Before discussing the improved production techniques in detail, we will list the changes which were incorporated into the three tube lot.

As agreed in the Statement of Work dated 25 April 1980, and as modified 10 September 1981, Varian will supply copies of those processes changed as a result of this MT Program. The parts that were affected by this program are

listed in Table 1 and Figure 1. Piece parts are illustrated in the color photographs (Figures 2 thru 6). Fifty-two parts are directly involved with the MT Program.

TABLE 1

IMPROVED PRODUCTION TECHNIQUES

VKU-7785F MT PROGRAM

ITEM	NOMENCLATURE	SECTION
1.	Broached Body	2
2.	Outer Heliarc Ring	27
3.	Tuner Adaptor Plate (2)	5
4.	Collector Socket	6
5.	Water Channel Plate (2)	27
6.	O/P Waveguide	9
7.	I/P and O/P Waveguide Adaptor (2)	9
8.	I/P and O/P Waveguide Extension (2)	9
9.	I/P and O/P Waveguide Flange (2)	9
10.	Body Manifold Coolant Tube (2)	4
11.	Exhaust Tube /Pumpout Assembly	8
12.	Pump-out Adaptor	8
13.	I/P Waveguide	9
14.	Cathode Socket	7
15.	Tuner Bridge (5)	14
16.	Tuner Rod (5)	14
17.	Tuner Rod Cap (5)	27
18.	Inner Heliarc Ring	27
19.	Tuner Body (5)	14
20.	Tuner Bottom Plate	27
21.	Tuner Top Plate	27
22.	Seal Frame	20
23.	Seal Assembly	20
24.	Spring Housing	23
25.	End Cap (5)	27
26.	Collector Cap	27

ITEM	NOMENCLATURE	SECTION
27.	Collector Cup (2)	27
28.	Collector Adaptor Ring	11
29.	Collector Body	10
30.	Collector Manifold	12
31.	Cooling Fin	18
32.	Heat Transfer Wafer	17
33.	BeO Ceramic Insulator	17
34.	Heat Transfer Wafer	17
35.	Heat Sink Washer	17
36.	RTV/ Molding/Cathode Potting	19
37.	Cathode Cooling Fin Spacer	28
38.	Heat Sink Strap	17
39.	Cathode Magnet Pole Piece	16
40.	Mount Bracket Assembly (Waveguide Side)	25
41.	Angle Bracket (left)	24
42.	"O" Ring	26
43.	Lock/Unlock Gear	27
44.	Lock/Unlock Cam	22
45.	Tuner Port (5)	27
46.	Motor Drive Cover	26
47.	Switch Cam	21
48.	Motor Top Plate	27
49.	Motor Center Plate	27
50.	Motor Base Plate	27
51.	Angle Bracket (Right)	24
52.	Mount Bracket (Tuner Side)	25

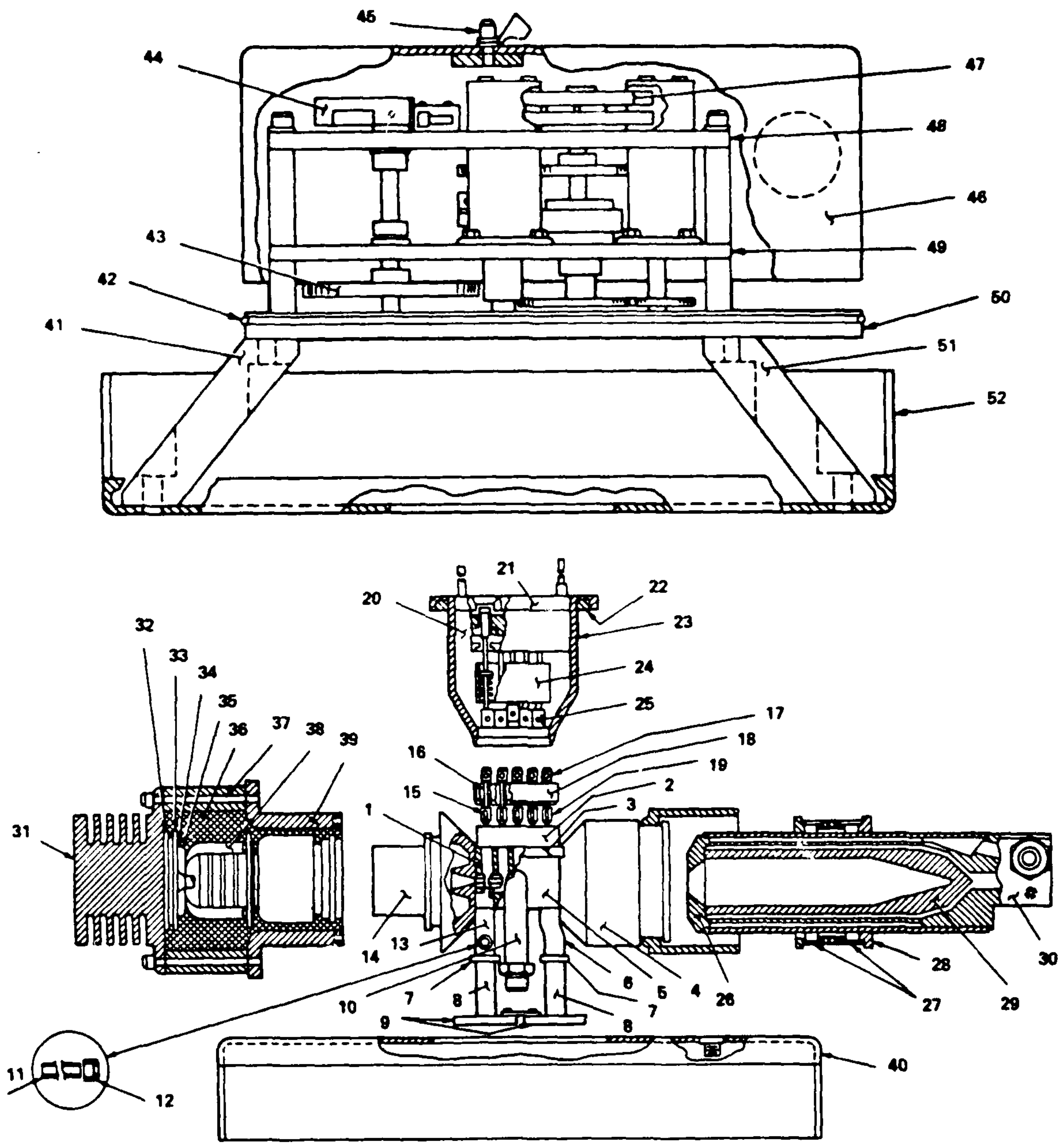
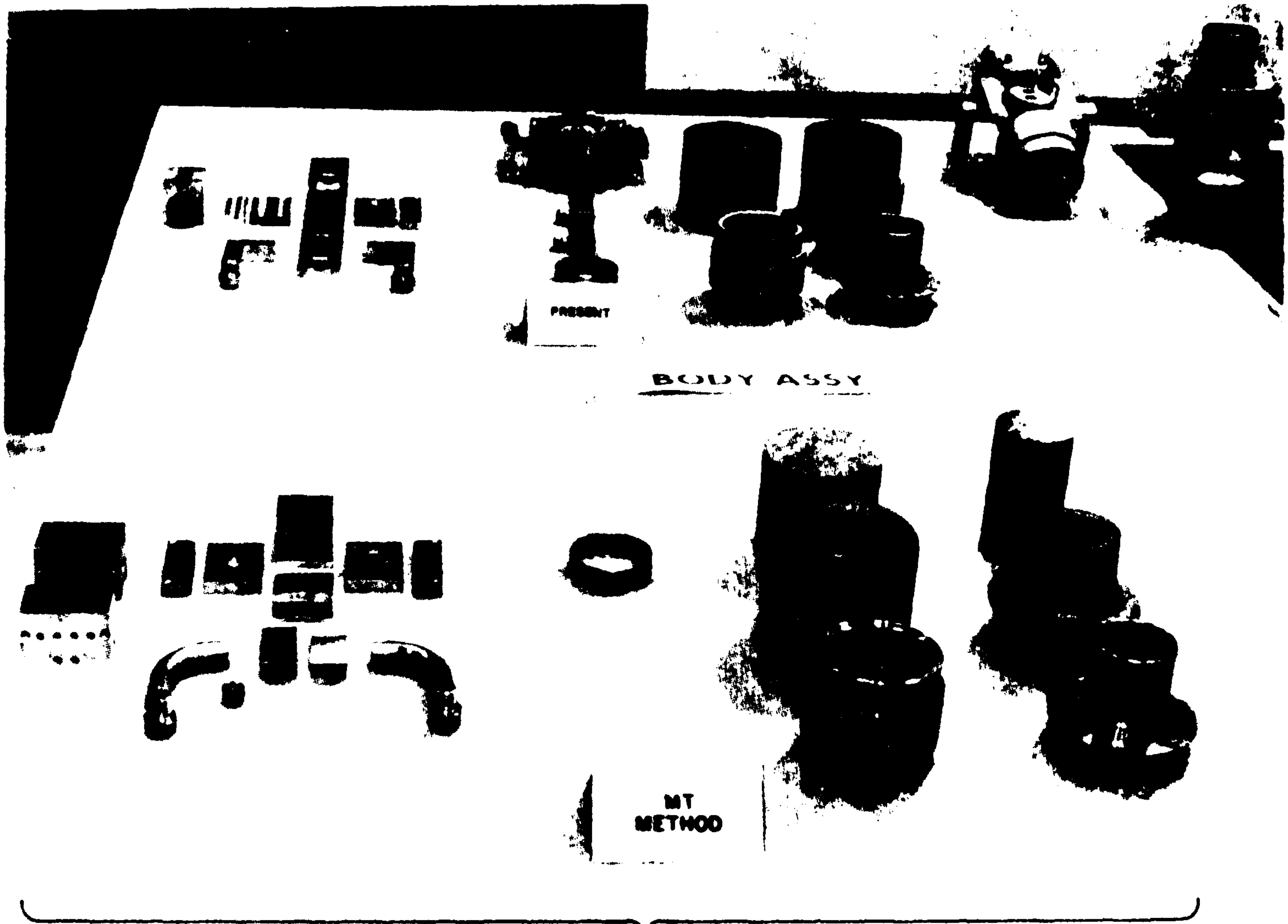
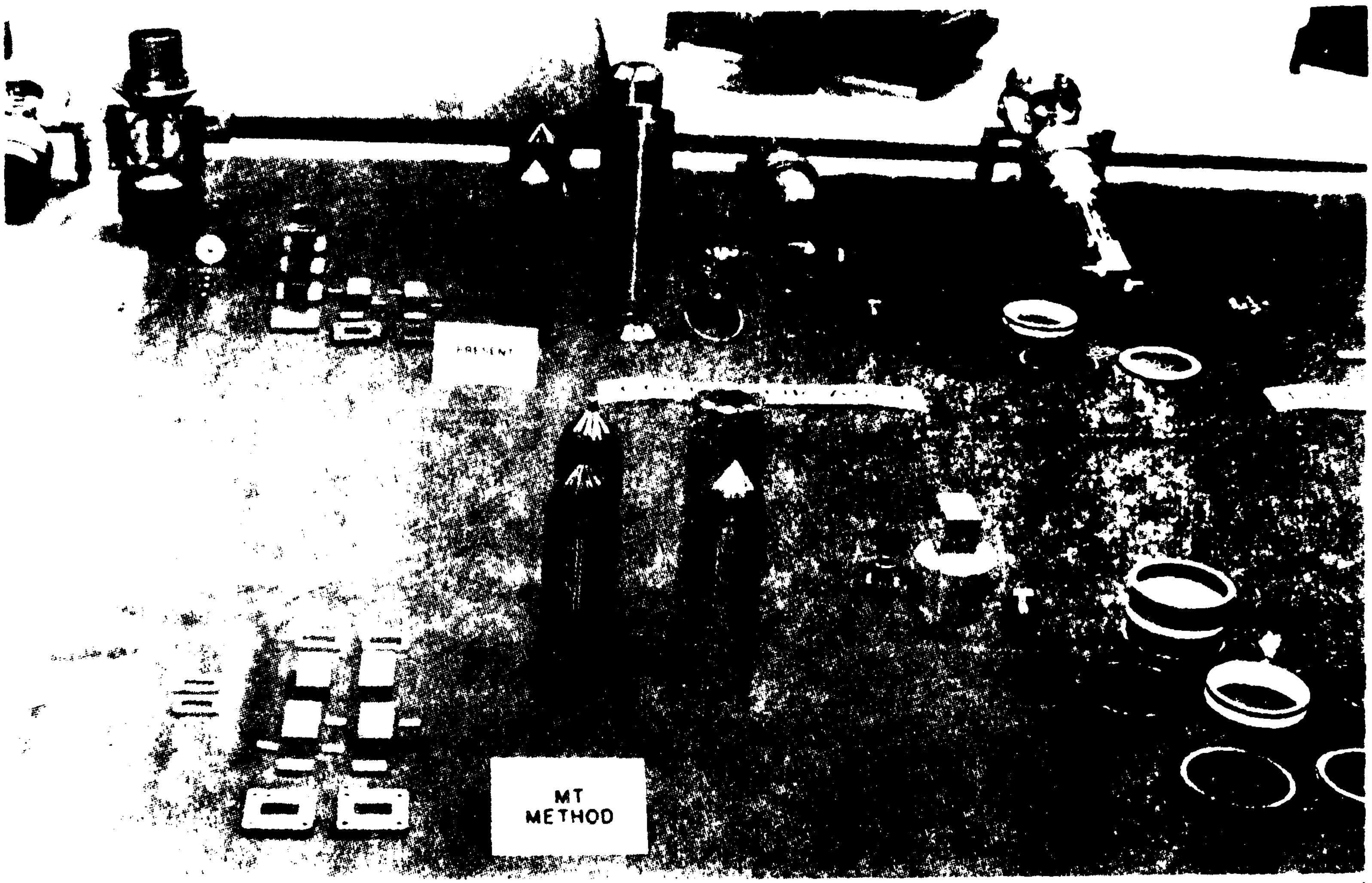


FIGURE 1. IMPROVED PRODUCTION TECHNIQUES



BODY ASSEMBLY

FIGURE 2



INPUT/OUTPUT
WAVEGUIDE ASSEMBLY

COLLECTOR ASSEMBLY

FIGURE 3

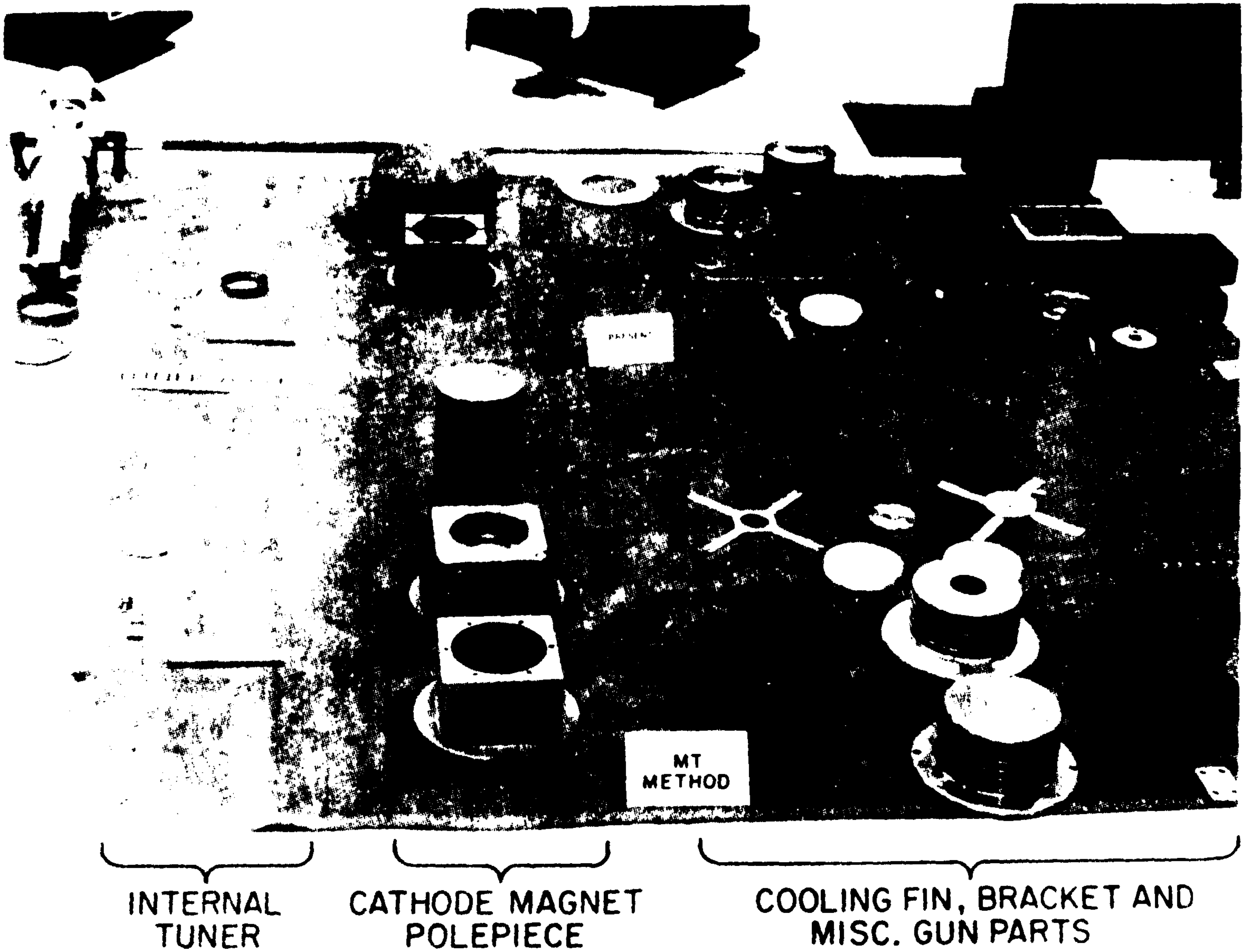

MT METHOD
INTERNAL TUNER
CATHODE MAGNET POLEPIECE
COOLING FIN, BRACKET AND MISC. GUN PARTS

FIGURE 4

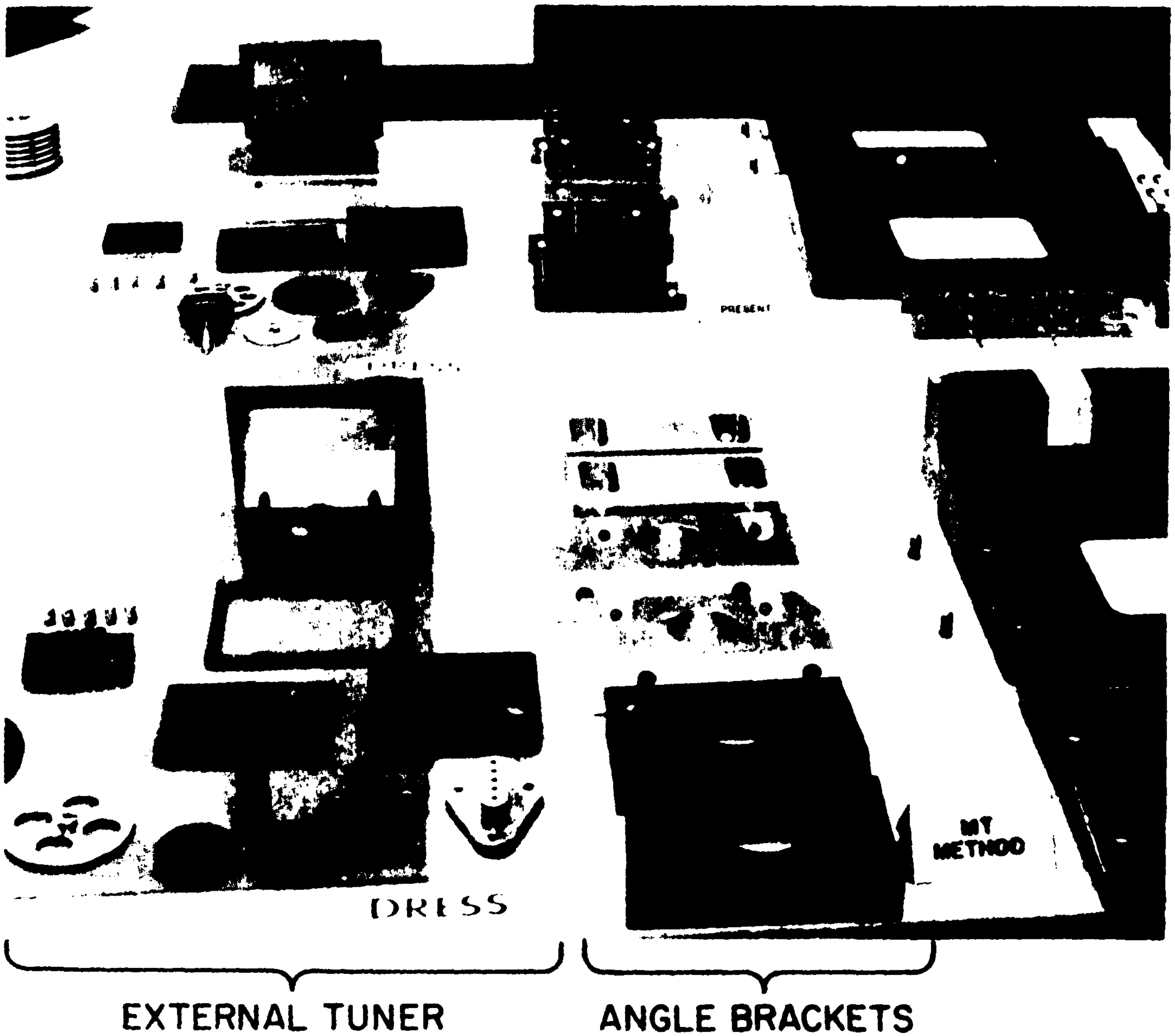


FIGURE 5

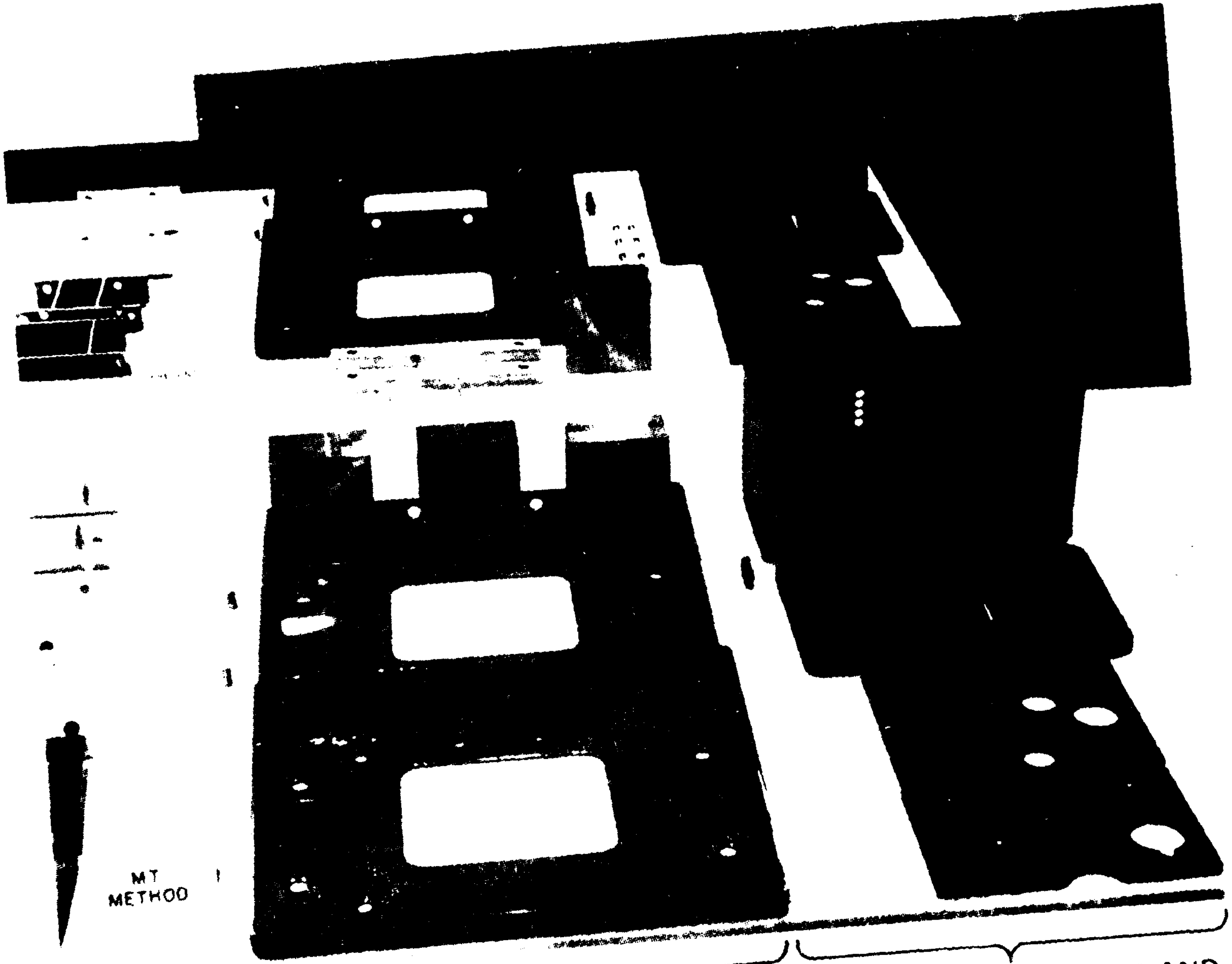


FIGURE 6

2. FIRST BODY ASSEMBLY

Engineering investigated various ways to improve throughput time and reduce the labor content associated with the fabrication and cold test of the klystron. The First Body Assembly had several proposed techniques which were under Engineering evaluation and, as a result, one has been selected. The new techniques adopted will provide a less costly and more repeatable fabrication process.

PRESENT METHOD - VKU-7785E

The first body assembly (Figure 7) is composed of six individual body sections and ten gold/copper (AuCu) braze wafers. These individual parts are stacked and put into a holding fixture. The complete assembly is then brazed into a unit body assembly. Due to the difficulty of maintaining a uniform repeatable structure during the body stack and braze operation, the body is subsequently machined to its final dimensions and the inner cavity dimensions have to be cold tested and individually tuned in order to achieve the proper tuning rates and frequencies. This present method requires more handling, more individual machined piece parts and more expensive braze material. Higher skilled personnel are subsequently required to cold tune the cavities and more attention to assembly details is required by the production engineers.

MT METHOD - VKU-7785F

Varian planned to reduce the cost of this assembly by one of the three techniques, as shown in Figures 8, 9, and 10. All three methods were under engineering evaluation for the ultimate benefits of parts manufacture, repeatability of the process, reduced number of process steps, reduced cold tuning, reduced engineering participation on the assembly floor, and the use of less skilled operators. The process change suggested in Figure 8 was selected as the most effective repeatable fabrication method. This technique includes a single broached body part with one braze of the bottom plate to the body. This process allows a more repeatable accurate formation

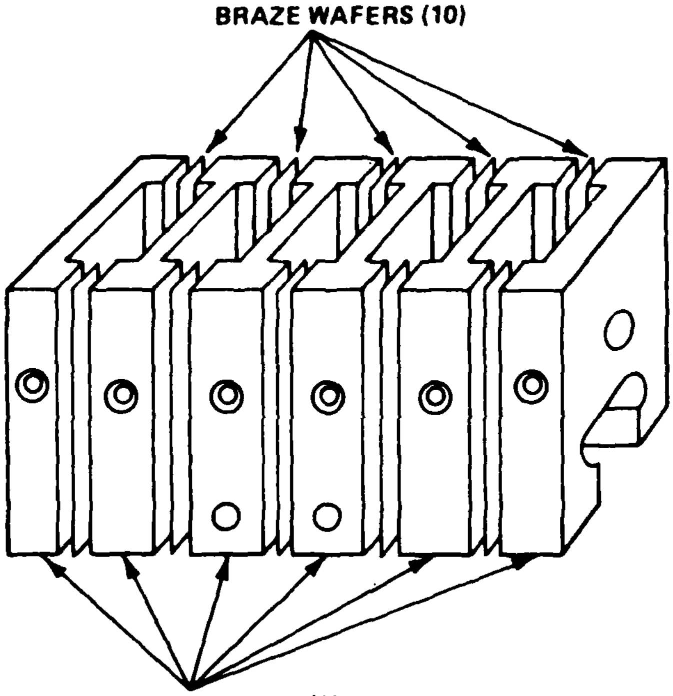
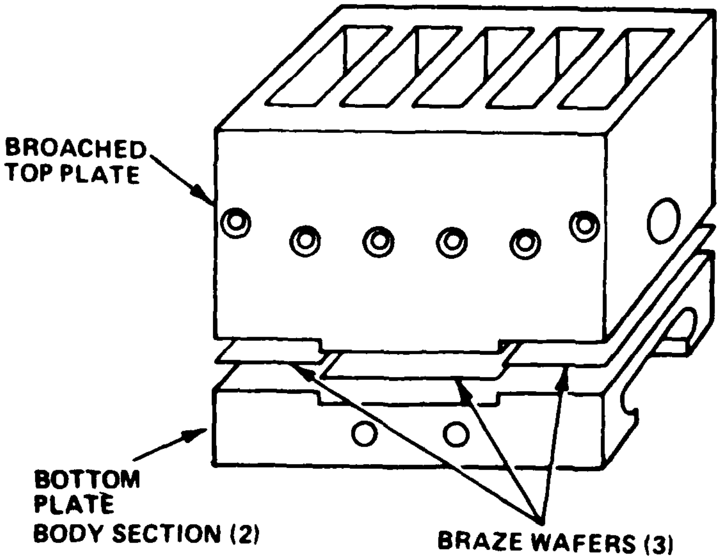


FIGURE 7. BODY ASSEMBLY – PRESENT



MT METHOD

FIGURE 8. BODY ASSEMBLY – MT METHOD

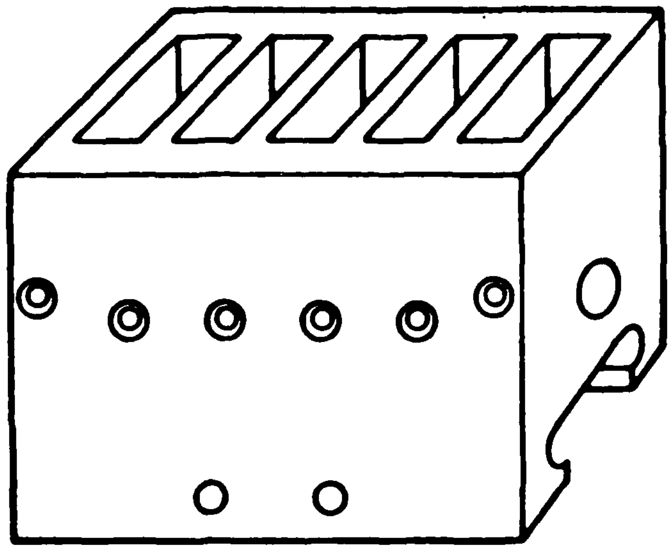


FIGURE 9. COLD FORMED BODY

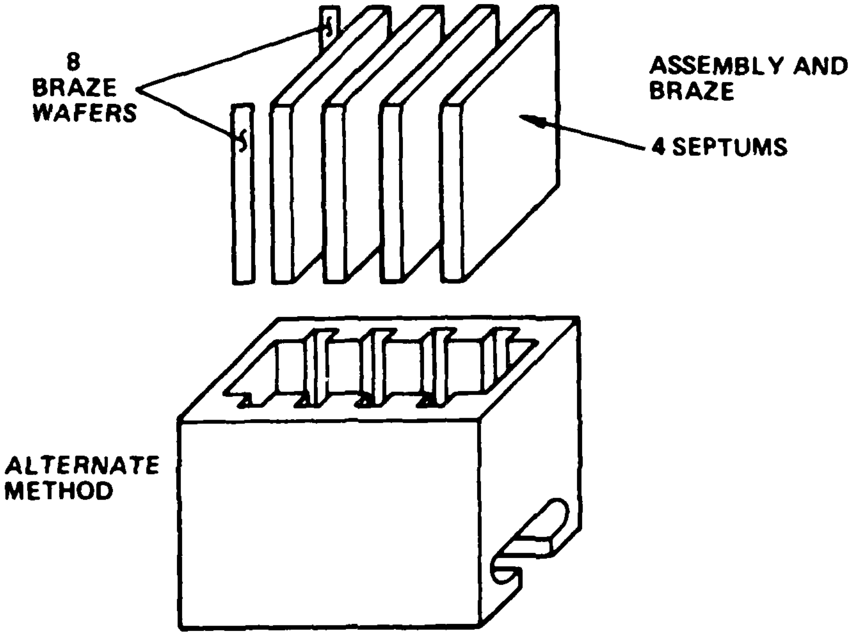


FIGURE 10. BODY ASSEMBLY – WITH SEPTUMS

of the cavity sizes, which eliminates the subsequent matching and individual adjustment of the cavity dimensions as is done in its present configuration. This new process reduces the cost of parts and assemblies, eliminates an additional machine operation, calculation of shims used to obtain the proper cavity size and reduces the in process steps and time. All this also allows the use of a lesser skilled person and reduces the time required by production engineers during the manufacture of the final body assembly.

The process change outlined in Figure 9 was to be a technique of cold forming or hobbing of the complete body cavities, using an hydraulic press and extruding the metal to its final configuration. This technique ran into problems, due mainly to the geometry of body section, the ratio of the cavity widths to lengths. Several techniques were tried without success to hob the final body assembly in a one shot cold forming operation. First the body was formed with five cavities but it was determined that the two outer cavities deflected outward due to less resistance on each end of the body. It was thought that the problem could be solved by forming two extra cavities, a total of seven and a little deeper than required, which would subsequently be machined off. It turned out the two extra cavities caused the second and fifth cavities to deflect inward. The tools were readjusted in trying to get the cavities to meet the dimensions and reduce tool breakage but the process could not meet the required objective. This technique was discarded in favor of the broaching technique, (Figure 8) although the hobbing technique is being used on other assemblies in this power klystron and on other klystrons manufactured by Varian.

The process change which was looked into and suggested in Figure 10 would have required a one shot cold form of the whole cavity structure, including the side slots to house the four wall sections which would be subsequently brazed in.

This technique would require additional braze operations and handling. Varian production engineers felt the outgassing time would be increased due to the possible entrapment of foreign material in septum braze joints. This technique was discarded in favor of the broaching technique.

3. BODY ASSEMBLY

One of the largest engineering cost-reduction concentrations was a consolidation of operations on the second body assembly. The second body assembly was composed of six subassemblies: first body assembly, channel plates, tuner adaptors, coolant manifold assemblies, input and output waveguides, and pumpout adaptor. Each of these subassemblies has an individual improved process and engineering has reduced the seven braze operations on the second body assembly to a one-braze operation. This was accomplished by using more sophisticated tooling and braze fixturing.

PRESENT METHOD - VKU-7785E

The present method of brazing the second body assembly is done in seven successive step brazes.

- Step 1 - Six body sections are brazed (described in Section 2, First Body Assembly)
- Step 2 - Left channel plate is brazed to the adaptor plate
- Step 3 - Right channel plate is brazed to the other adaptor plate
- Step 4 - Left and right channel plate assemblies are brazed to the first body
- Step 5 - Right water fitting is brazed to the coolant manifold
- Step 6 - Left water fitting is brazed to the other coolant manifold
- Step 7 - Steps 2 thru 6 above, plus the pumpout adaptor and the waveguides are brazed to the first body assembly.

The above method requires excessive handling, transportation to and from the braze furnaces, with an associated high labor content. (See Figure 11.)

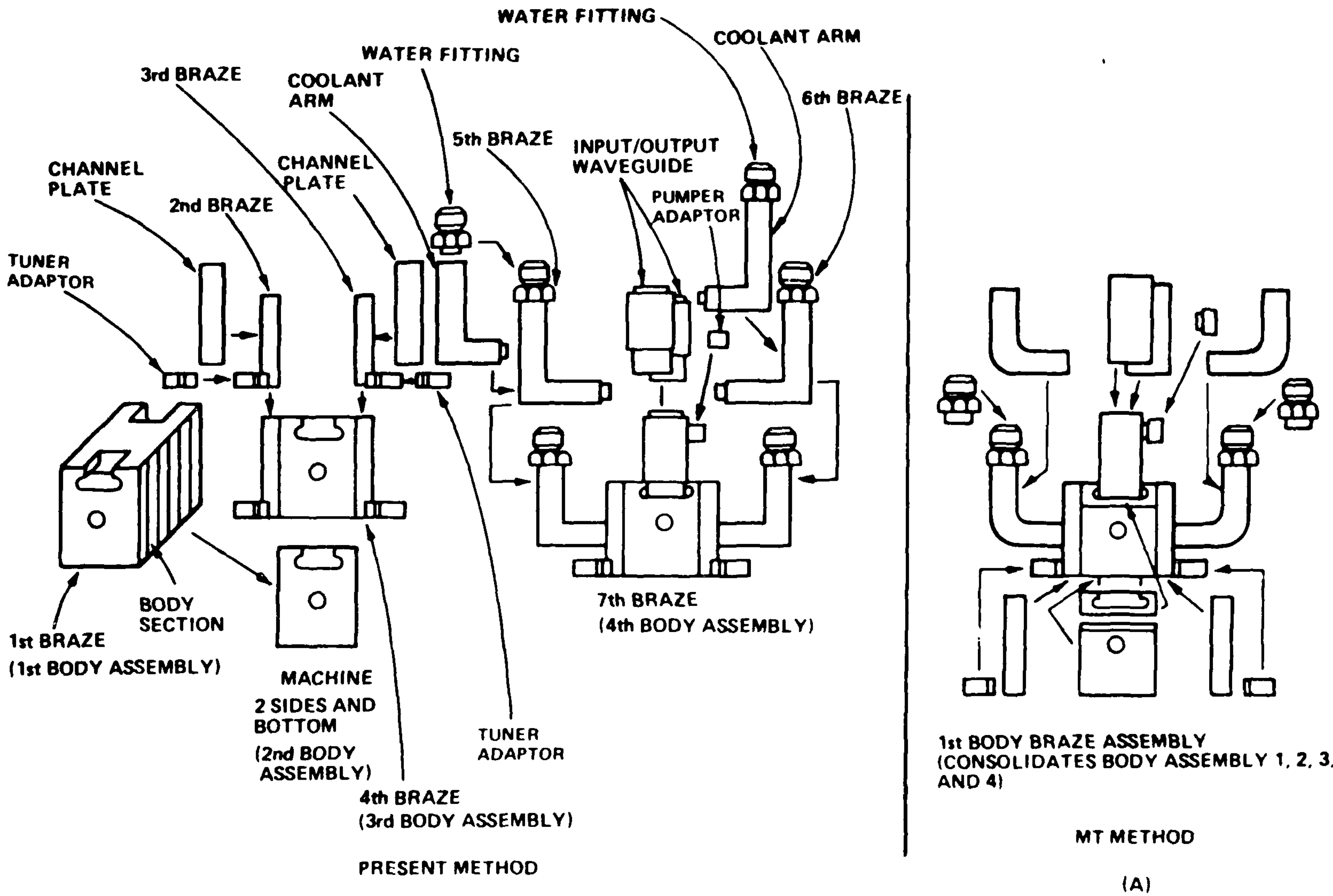


FIGURE 11. VKU-7785F BODY ASSEMBLY

MT METHOD - VKU-7785F

Varian reduced the number of braze operations to one by designing a new alignment tool and braze fixture. The second body assembly is completed in a one-braze operation by assembling the following parts into the alignment tool:

1. Two channel plates
2. Two tuner adaptor plates
3. Two coolant manifolds
4. Input and output waveguides
5. Two water fittings
6. Pumpout adaptor

The assembly is then placed into the braze fixture for a single braze operation. (See Figure 11 A.)

4. BODY MANIFOLD COOLANT TUBES

To improve the assembly techniques and reduce the labor content of the body manifold coolant tubes, Varian made changes to the fabrication methods through reduced handling and machining operations.

PRESENT METHOD - VKU-7785E

The present body manifold coolant tubes (two per tube) are fabricated by starting with a solid piece of plate stock. The plate stock is sawed to the rough dimensions of the finished part, (Figure 12), then it is milled on all outer surfaces to the finished dimensions. The part is then put into a lathe and one end is drilled, counterbored and turned. The part is removed and rechucked so the other end can be machined, drilled, counterbored and turned.

A stainless steel water fitting is brazed into one end of the coolant tube. Subsequent assembly operations require the two coolant tubes to be brazed into the first body assembly using elaborate brazing and locating fixtures.

MT METHOD - VKU-7785F

The new body manifold coolant tubes are made from copper tubing. The tubing is bent to the required configuration, cut to the proper length and the two coolant tubes are brazed to the first body assembly on a subsequent braze operation which is described in the body assembly, Section 3 of this report. (See Figure 12 A.)

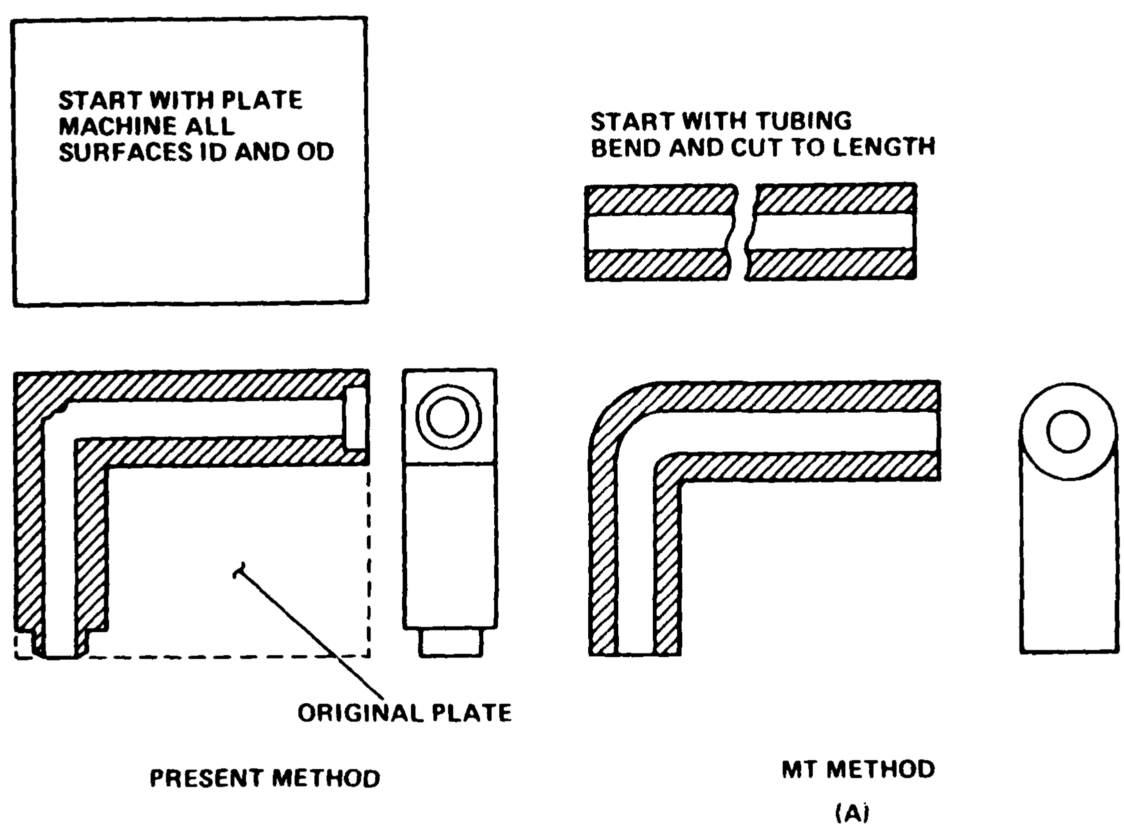


FIGURE 12. BODY MANIFOLD COOLANT TUBE

5. TUNER ADAPTOR PLATE

To improve the throughput time and reduce the labor content of the body assembly, Varian has made a series of changes to the fabrication techniques of the tuner adaptor plates.

PRESENT METHOD VKU-7785E

The present tuner adaptor plates (two per tube) require that the finished part be .250" ± .005" thick, with surface A and surface B flat and parallel to each other. This is accompanied by a number of additional close-tolerance machining operations that are presently required for self jigging and locating the adaptor plates to the first body assembly during the subsequent assembly operations. In order to accomplish these requirements, Varian starts with a thicker material, mills both sides to the required dimensions, and then mills the two .050" extensions which self locate the adaptor plates to the body assembly. (See Figure 13).

MT METHOD - VKU-7785F

The two tuner adaptor plates have been redimensioned to reduce the fabrication time and improve the manufacturing methods. These changes eliminate the self locating .050" extension on each end of the adaptor plates. The need for these extensions has been eliminated by using a redesigned braze fixture which will capture and precisely locate both tuner adaptor plates relative to the body cavities.

Another change eliminates the use of the 3/8" thick material which requires several milling operations by replacing it with 1/4" thick stock material. This eliminates the double sided machining operations plus five additional close tolerance machining operations and the machine set-up times. (See Figure 13 A). This part is brazed to the body assembly as described in Section 3.

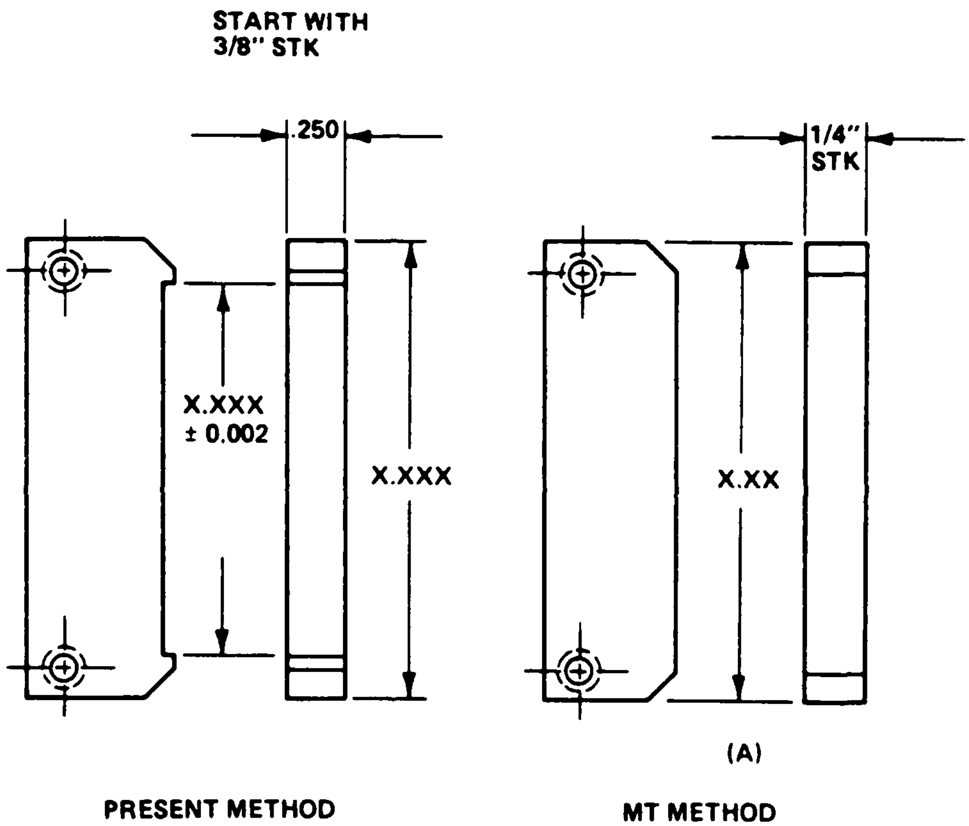


FIGURE 13. TUNER ADAPTOR PLATE

6. COLLECTOR SOCKET

Varian changed the fabrication method on the collector socket which reduces material cost, handling, and machining operations.

PRESENT METHOD - VKU-7785E

The collector socket is hogged from a 2 3/4" diameter bar which has been rough cut to length. This piece weighs 4.7 pounds. After the two rough machine operations are completed, the part is chemically cleaned, then taken to the furnace room where an annealing operation removes the stresses. The part is then returned to the machine shop for the final three machine operations. (See Figure 14.)

MT METHOD - VKU-7785F

This part will be purchased as a 2 1/2" diameter forged blank which has already been normalized, thereby eliminating the subsequent stress relief annealing operation. This blank weighs 3.3 pounds, which represents a significant labor and material cost reduction obtained by eliminating the rough machining and chemical cleaning operations. The only operation required is machining the part to the final dimensions. This new method also eliminates excessive transportation and handling of the part. (See Figure 14 A.)

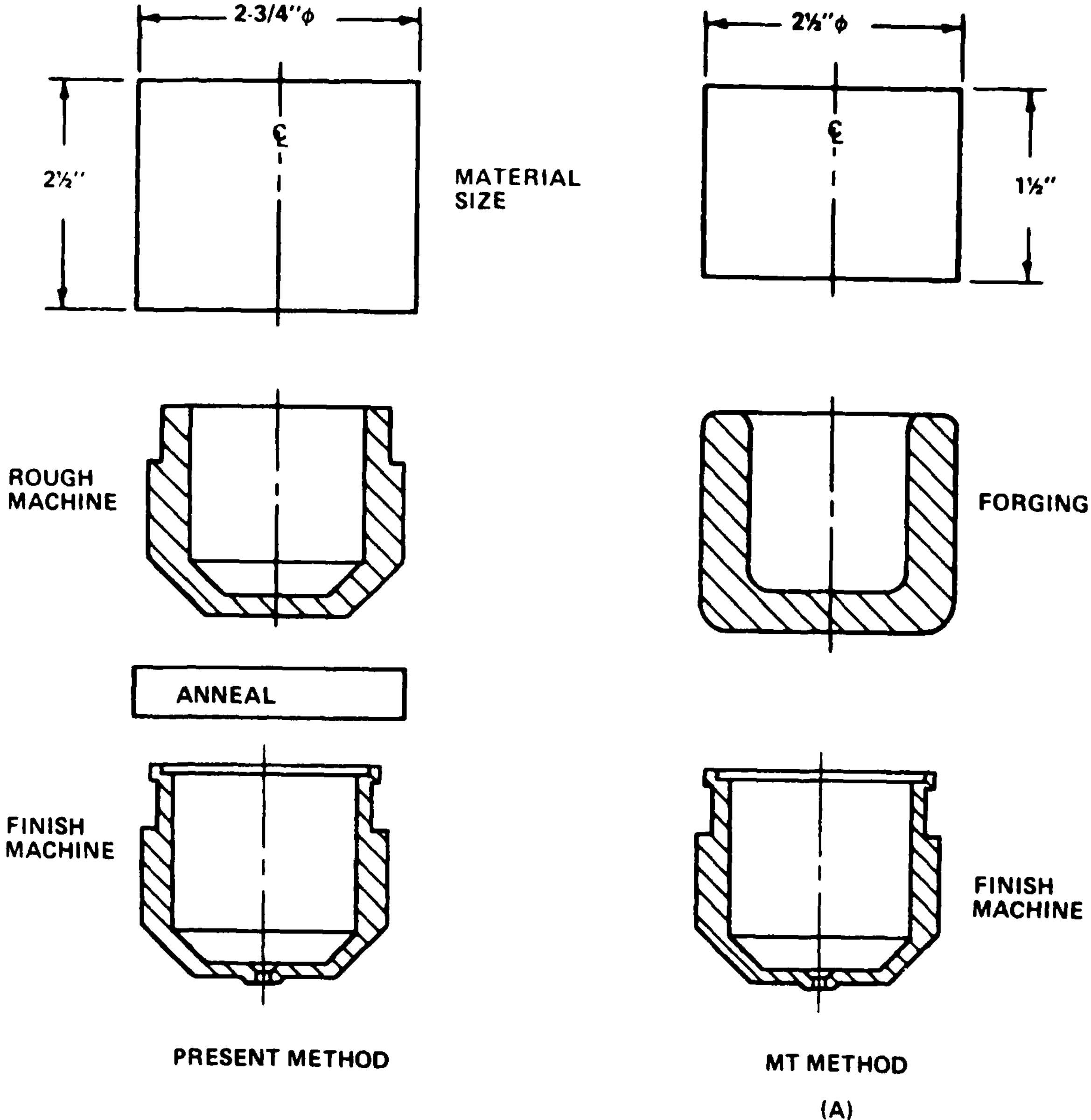


FIGURE 14. COLLECTOR SOCKET

7. CATHODE SOCKET

The changes in the fabrication method for this part have reduced material cost, handling, and machining operations.

PRESENT METHOD - VKU-7785E

The cathode socket is hogged from a 3" diameter bar which has been rough cut to length. This piece weighs 5.1 pounds. After two rough machine operations are completed, the part is chemically cleaned, then taken to the furnace room where an annealing operation removes the stresses. The part is then returned to the machine shop for final machining operations. (See Figure 15.)

MT METHOD - VKU-7785F

This part will be purchased as a 1 3/4" diameter forged blank which has already been normalized, thereby eliminating the subsequent stress relief annealing operation. This blank weighs 2.9 pounds, which represents a significant labor and material cost reduction by eliminating the rough machining and chemical cleaning operations. The only operation required is to machine the part to the final dimensions. This new method also eliminates excessive transportation and handling of the part. (See Figure 15 A.)

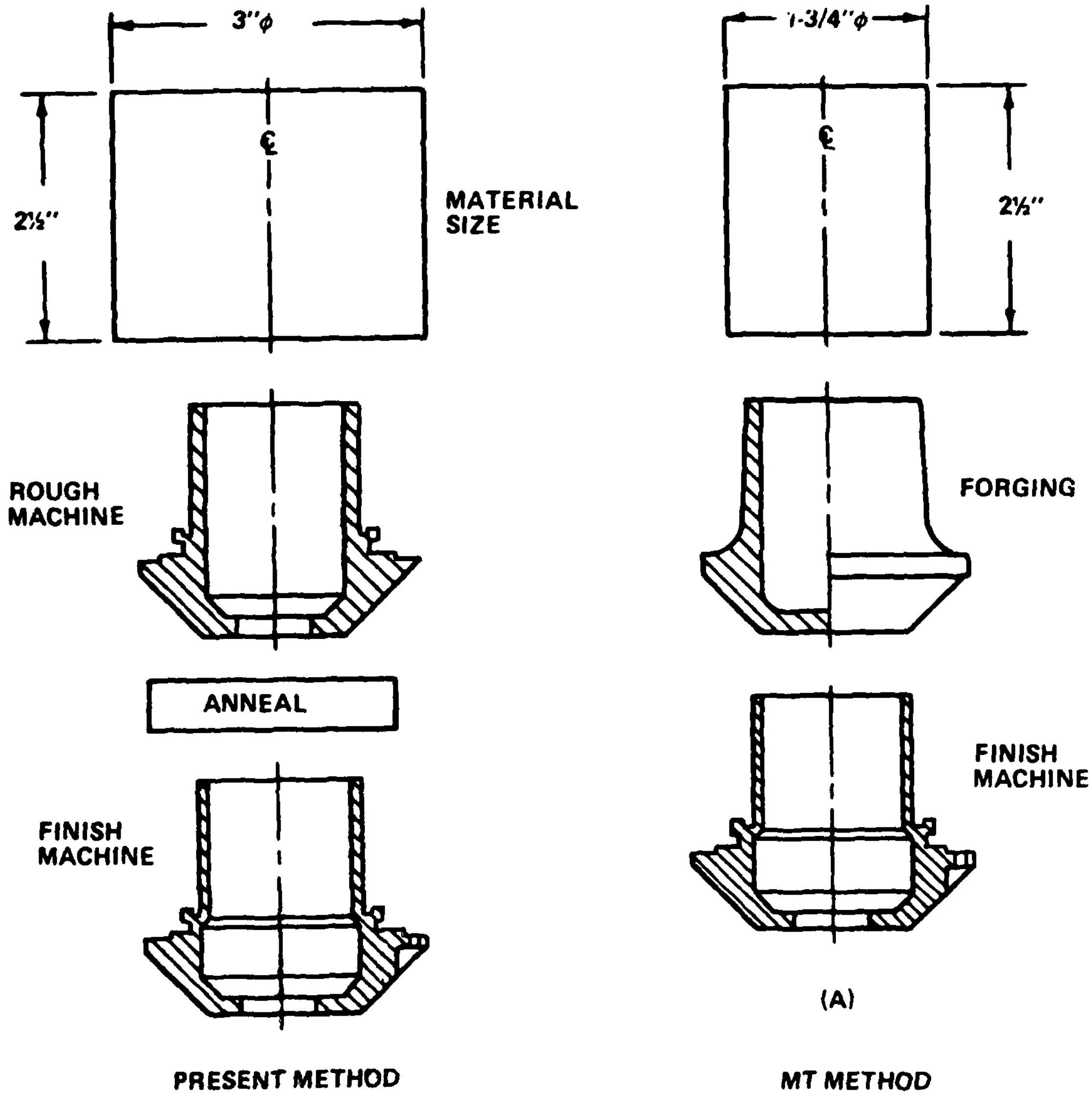


FIGURE 15. CATHODE SOCKET

8. PUMPOUT ADAPTOR AND TUBULATION ASSEMBLY

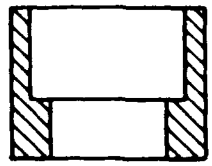
To reduce cost, Varian reduced the number of parts, assembly operations and braze cycles of this assembly.

PRESENT METHOD - VKU-7785E

The pumpout adaptor in Figure 16 is machined from Monel bar stock. In the pumpout tubulation assembly, (Figure 17), the present technique requires three braze joints and three parts. The exhaust tube is cut to length and the diameter at one end is expanded to form a transition to the larger diameter exhaust tube. The transition tube is brazed to the pumpout adaptor and larger exhaust tube.

MT METHOD - VKU-7785F

Varian designed a die to coin the pumpout adaptor to the final dimensions (Figure 16 A), which will accept a standard 5/16" OD tubing. This new technique eliminates the transition tube, expanding operation, and one braze joint. (See Figure 17 A.)



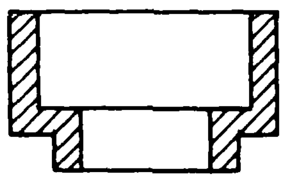
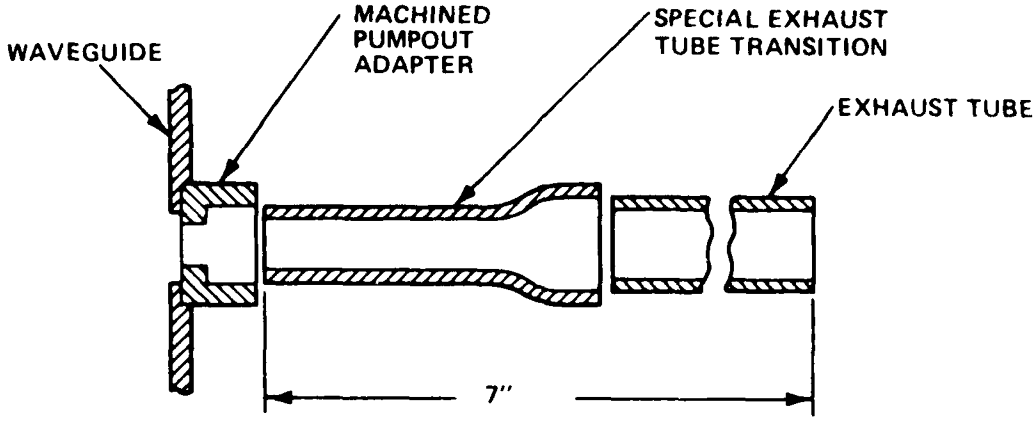
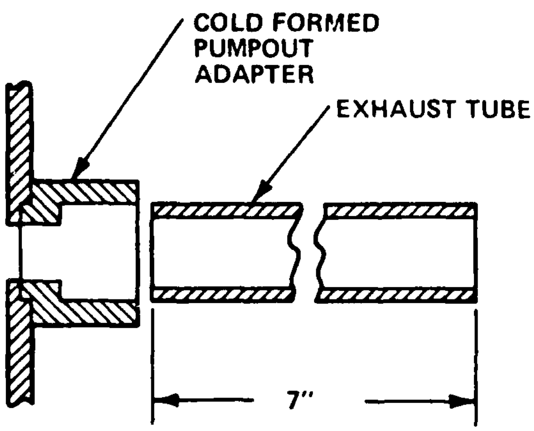


FIGURE 16. PUMP-OUT ADAPTOR



(3 PIECES 3 BRAZE JOINTS)

PRESENT METHOD



2 PIECES 2 BRAZE JOINTS (A)

MT METHOD

FIGURE 17. PUMP-OUT ASSEMBLY

9. INPUT/OUTPUT WAVEGUIDE ASSEMBLY

Varian changed the manufacturing methods and techniques to improve the yield and reduce the waveguide assembly time and parts cost. The present waveguide assembly consists of six parts which are, for the most part machined.

PRESENT METHOD - VKU-7785E

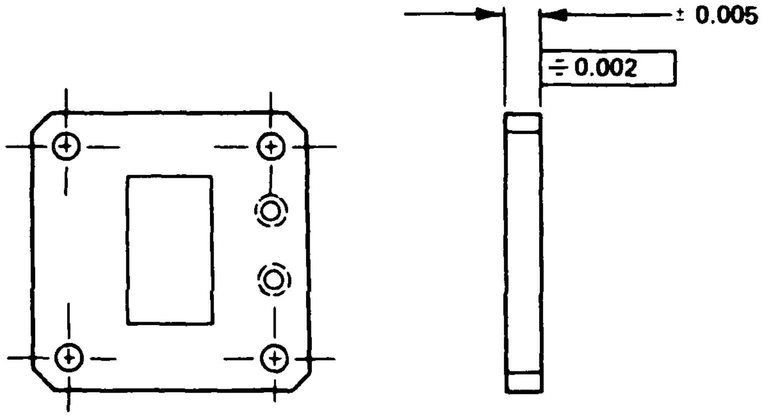
Waveguide Flange - The waveguide flange (two per tube) is sawed to rough dimensions from 1/4" flat stock. Surfaces of the parts are then milled to final dimensions. ID is broached, and six holes are machined of which two are threaded. The final step is a lathe turning operation. (See Figure 19).

Waveguide Adaptor - The waveguide adaptor (two per tube) is machined from flat stock, and requires subsequent milling of all surfaces and broaching of the ID to the final dimensions. (See Item 6 of Figure 19.)

Waveguide Extension - The waveguide extension (two per tube), (Item 2, Figure 19), requires both ends and all four sides machined to a ± .001" tolerance to fit the waveguide flange at one end and to position the waveguide adaptor at the other end. Waveguide adaptor and flange are then brazed to the waveguide extension.

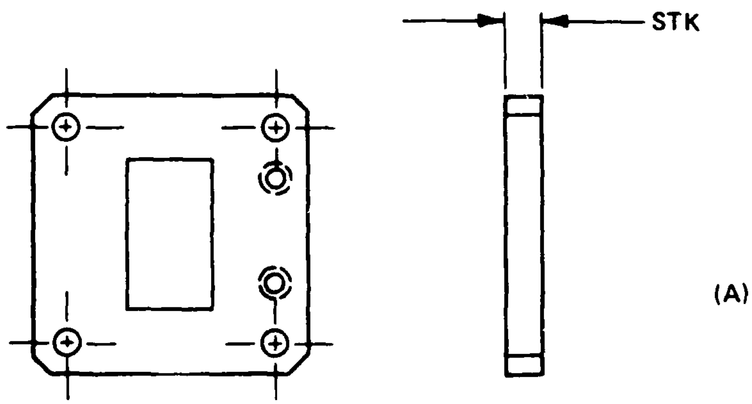
Waveguide Assembly - The waveguide assembly as shown in Figure 19 is assembled as follows:

1. Assemble the finished waveguide flange and one iris plate to the waveguide extension
2. Braze and inspect
3. Broach and size waveguide extension ID to provide a close tolerance fit with the ceramic block window
4. Install the ceramic block window, the other iris plate, and the waveguide adaptor to the waveguide extension



MACHINE 100%

PRESENT METHOD



PUNCH PRESS AND MACHINE 2 THREADED HOLES
BLANK
PIERCE
SHAVE

MT METHOD

FIGURE 18. WAVEGUIDE FLANGE

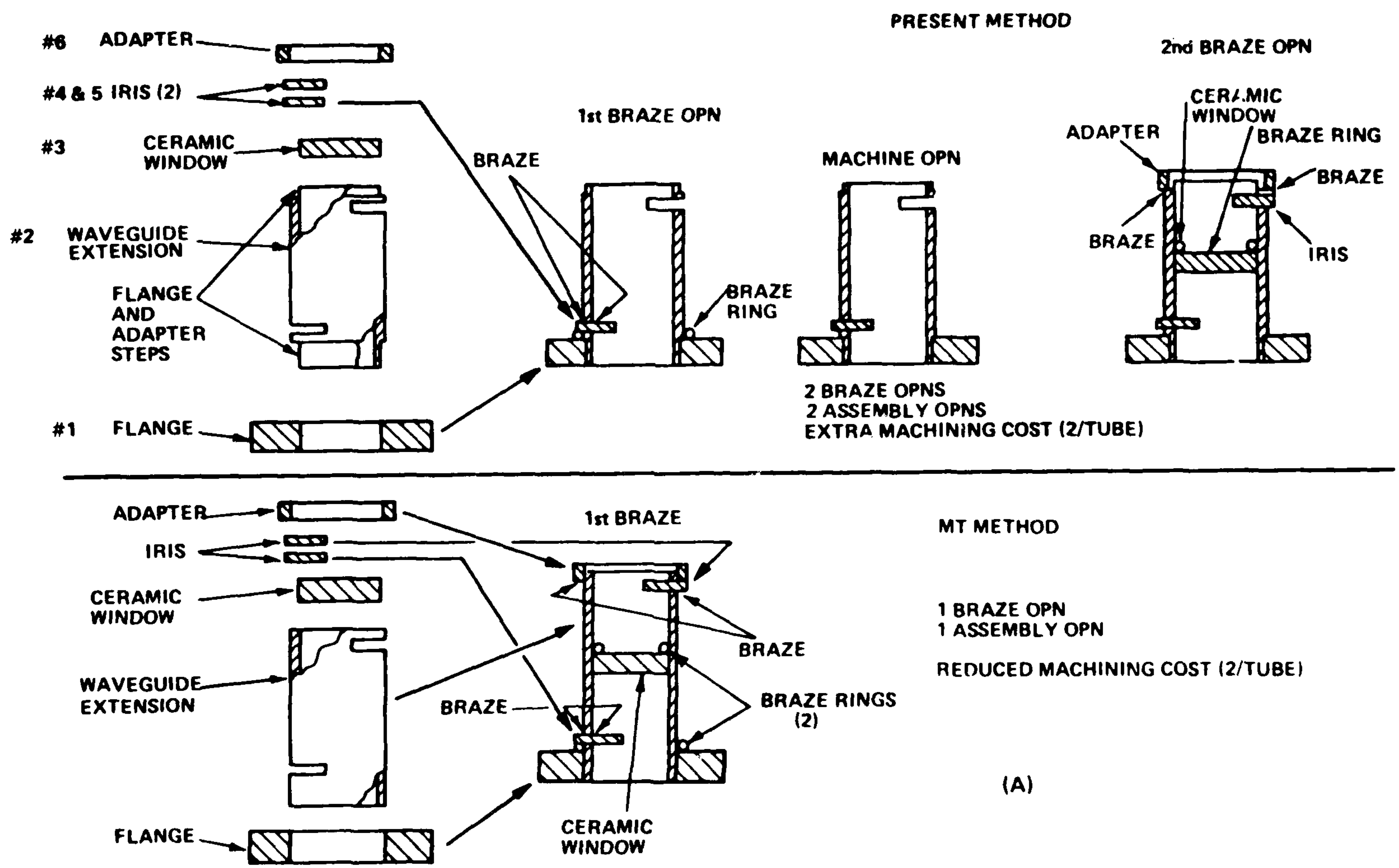


FIGURE 19. INPUT/OUTPUT WAVEGUIDE ASSEMBLY

4. Braze and inspect the entire assembly

Due to soft copper and the thin walls the yield on this part is low.

MT METHOD - VKU-7785F

Waveguide Flange - Varian has purchased special tooling to blank the OD and ID from 1/8" flat stock. This operation is followed by a pierce and shave die operation to bring the ID to its final close-tolerance dimensions. The final operation consists of machining two threaded holes. This part cost is greatly reduced with no loss of quality. (Refer to Figure 18 A.)

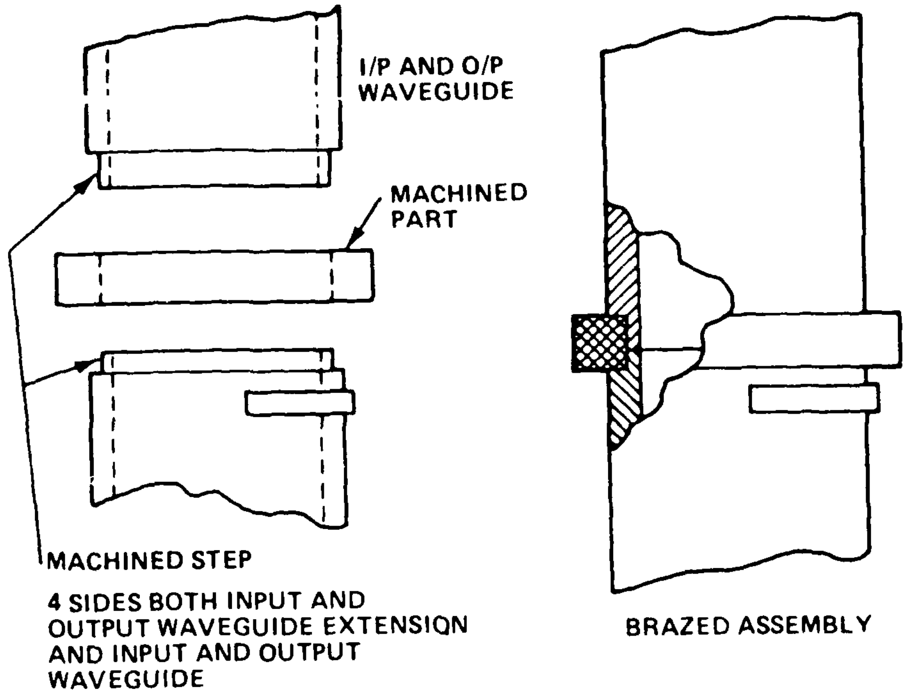
Waveguide Adaptor - Varian will now blank the waveguide adaptor, followed by a pierce and shave die operation. This reduces the amount of handling and remachining required to make the mating parts fit properly, thereby reducing cost.

Waveguide Extension - Varian has purchased a tool to broach the ID prior to machining the two iris slots. This eliminates distortion and reduces chances of damage due to broaching and sizing the part after the first braze. This new approach also eliminates machining ends of the waveguide extensions to permit assembly of the mating parts. This technique reduces the piece part costs and greatly reduces the potential of scrapping at a later assembly operation.

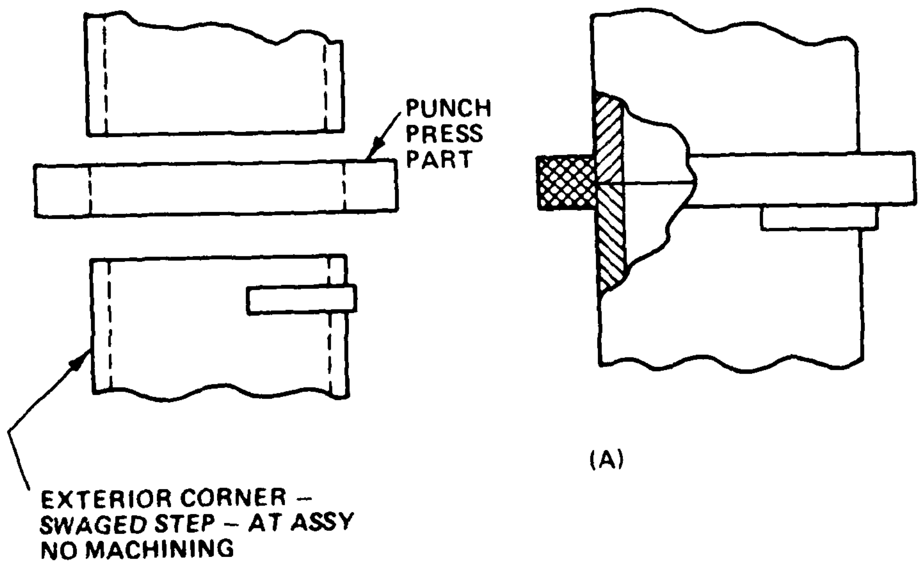
Waveguide Assembly - The new method of manufacturing and assembling the waveguide assembly is as follows:

1. Assemble the waveguide adaptor, two iris plates, and waveguide flange to the waveguide extension and ceramic block assembly
2. Braze and inspect the complete assembly

This method reduces individual parts costs, eliminates an intermediate broaching operation, increases the yield factor, and requires only one assembly, braze and inspection sequence. (See Figure 19 A.)



PRESENT METHOD



MT METHOD

FIGURE 20. ASSEMBLY OF WINDOW ASSEMBLY TO TUBE

10. COLLECTOR BODY

The collector body is hobbed (cold formed) as a result of the Engineering attempt to hob the first body assembly. (See Section 2.)

PRESENT METHOD - VKU-7785E

The collector body is 100% machined from bar stock in five discrete operations. (See Figure 21)

1. Machine blank
2. Rough machine internal cavity
3. Final machine internal cavity
4. Machine angles
5. Mill splines

MT METHOD - VKU-7785F

The internal cavity dimensions are hobbed using special tooling and hydraulic pressures. The collector body internal cavity dimensions have been difficult to machine to the finished dimensions, whereas the new technique produces a very repeatable operation with closely held dimensions. The water passage splines and external final dimensions are machined. (See Figure 21 A)

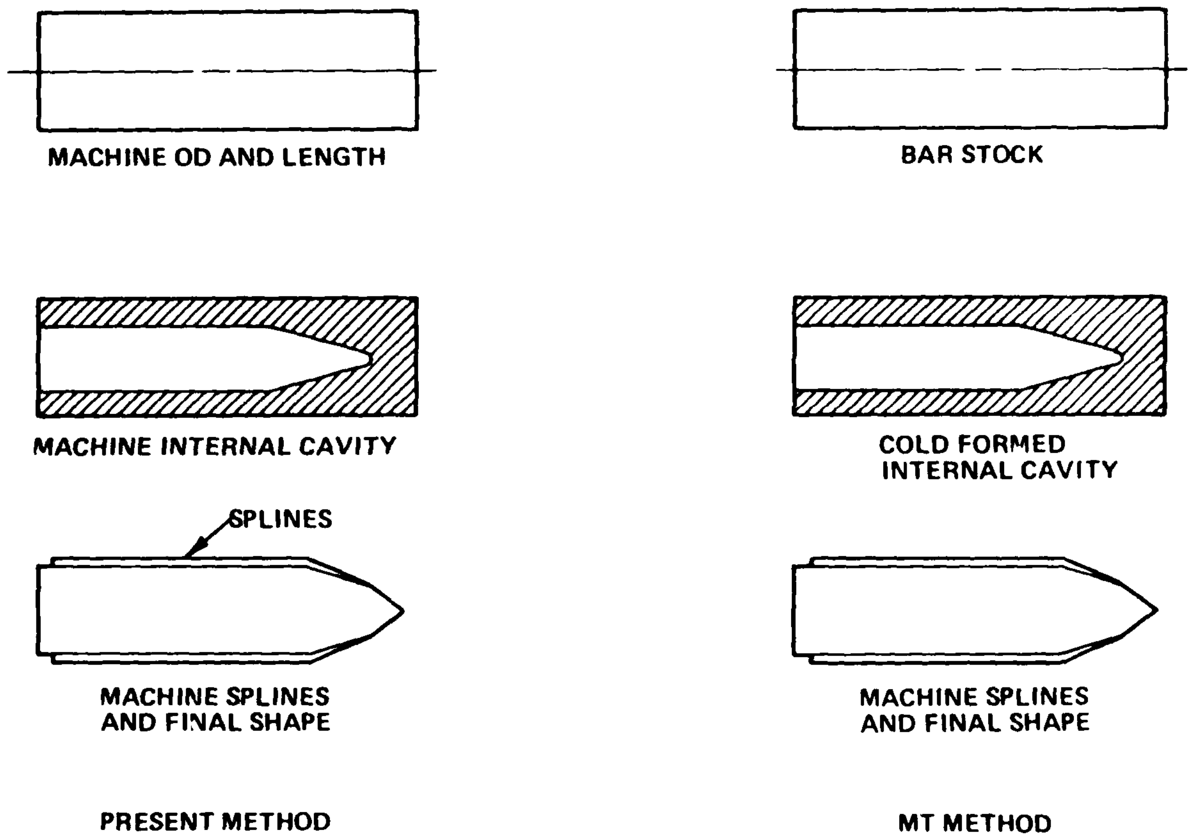


FIGURE 21. COLLECTOR BODY (A)

11. COLLECTOR SEAL ASSEMBLY

To improve assembly techniques, reduce labor content and lower parts cost of the collector seal assembly, Varian changed the assembly sequence, process techniques and braze schedules.

PRESENT METHOD - VKU-7785E

The collector seal assembly is presently fabricated using five successive assembly operations with five braze cycles using five braze rings and six parts. (See Figure 22)

Step 1. The collector cup is assembled to the seal keeper with one braze ring applied to ID of the cup. The quality and integrity of the brazed subassembly is then bench checked.

Step 2. This seal keeper subassembly is then assembled to the collector ceramic seal with one braze ring applied to the ID; the quality of the brazed subassembly is then checked for seal and braze integrity.

Step 3. Collector seal adaptor is assembled to another collector seal keeper with one braze ring applied to the OD. The quality of this braze subassembly is then checked.

Step 4. This keeper adaptor subassembly is then assembled to another collector cup with one braze ring applied to the ID; again the quality of the brazed subassembly is then checked.

Step 5. The seal keeper subassembly from Step 2 is assembled to the keeper adaptor subassembly from Step 4 with one braze ring applied to the ID of the cup. The brazed assembly is then leak checked, packaged and stored for future use.

The present method requires excessive handling, transportation to and from the braze furnace, and five intermediate inspection checks.

MT METHOD - VKU-7785F

The change in the assembly sequence of the collector seal assembly, as shown in Figure 22 A, has reduced the number of parts to five by making the seal

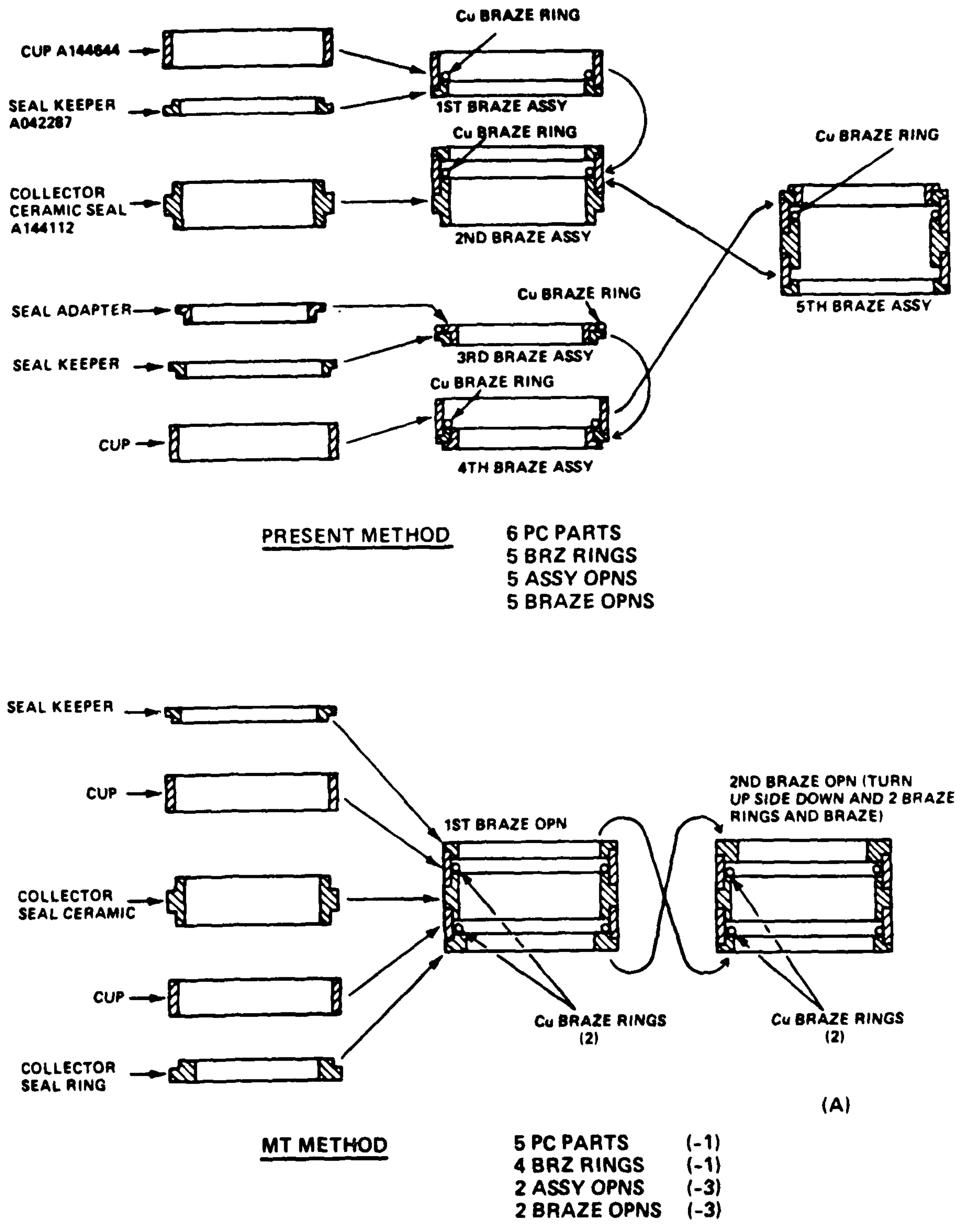


FIGURE 22. COLLECTOR SEAL ASSEMBLY

keeper and seal adaptor as one part. Varian now assembles all the parts with two assembly operations. The braze cycle is made after one braze ring is placed on ID of the cup and one ring on the ID of the seal ring. The second braze cycle requires turning the brazed assembly upside down and adding one more braze ring to the ID of the cup and one to the ID of the seal ring. This method reduces the total parts and braze rings by one and eliminates three assembly operations, braze cycles, and inspection checks. This new method also eliminates the fit problems caused by warping of parts during sequential subassembly brazes of present method.

12. COLLECTOR MANIFOLD ASSEMBLY

To reduce collector manifold assembly cost, Varian reduced the number of parts, assembly operations and braze cycles.

PRESENT METHOD - VKU-7785E

The collector manifold assembly is presently assembled as follows:

Step 1. Insert modified water fittings into the coolant block, apply braze wire between the two parts, braze and inspect quality of braze joints. (See Figure 23)

Step 2. Assemble the water scoop, two nipples and collector manifold to coolant block assembly, using braze rings around water scoop and block.

MT METHOD - VKU-7785F

Varian reduced cost of the collector manifold assembly by incorporating collector block and collector manifold into one part, thus eliminating two nipples and water scoop. Two water fittings are assembled to the new one-piece part and brazed. This new method has resulted in a reduction of three parts, one assembly operation, one braze cycle, one inspection stage, and the quantity of copper/gold braze alloy required (See Figure 23 A.)

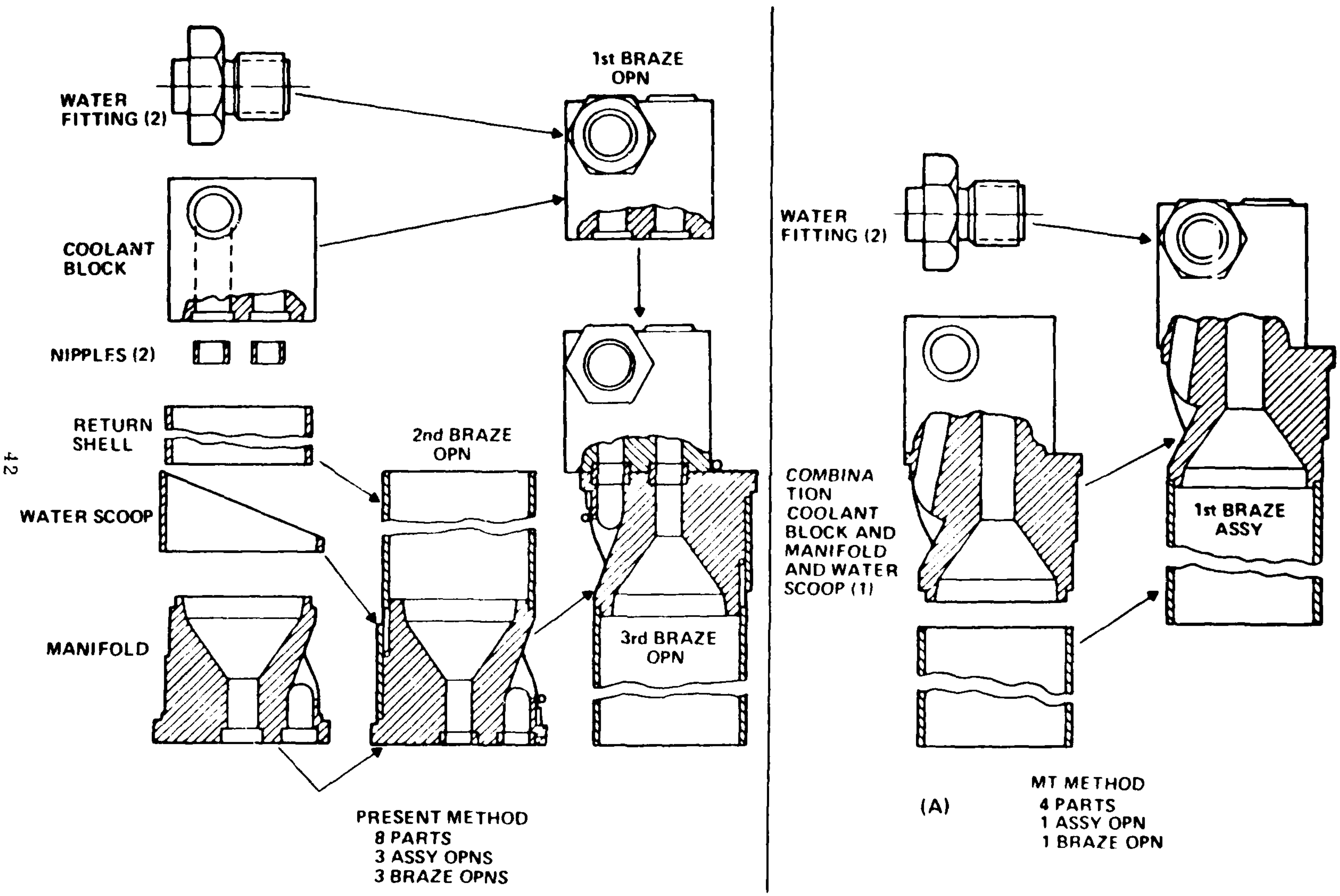


FIGURE 23. COLLECTOR MANIFOLD ASSEMBLY

13. FINAL COLLECTOR ASSEMBLY

To improve assembly throughput time, reduce handling and braze cycles, Varian has made changes to fabrication methods of the major collector subassemblies.

PRESENT METHOD - VKU-7785E

The final collector assembly is completed using four assembly and three braze operations: (Figure 24)

Step 1. Take collector body (See Section 10), and insert into the body sleeve. Install collector cap and braze the assembly.

Step 2. and 3. Take body and cap assembly and install the outer sleeve over the assembly. Take collector manifold assembly (See Section 12), and assemble it to the body assembly; apply braze wire and braze entire assembly.

Step 4. Take collector seal assembly (See Section 11), install over the collector assembly and braze seal assembly to final collector assembly.

MT METHOD - VKU-7785F

The MT method completes the final collector assembly using two assembly and braze operations: (Figure 24 A)

Step 1. Braze collector body (See Section 10 A) with collector cap.

Step 2. Assemble the collector body and cap assembly from Step 1 with the collector manifold assembly (See Section 12 A), outer sleeve, collector seal assembly (See Section 11 A), and braze the final collector assembly.

This technique reduces the number of parts, (Section 11 and 12), sub brazes and machining operations. This, in turn, reduces the cost through less handling, less labor and movement of assemblies.

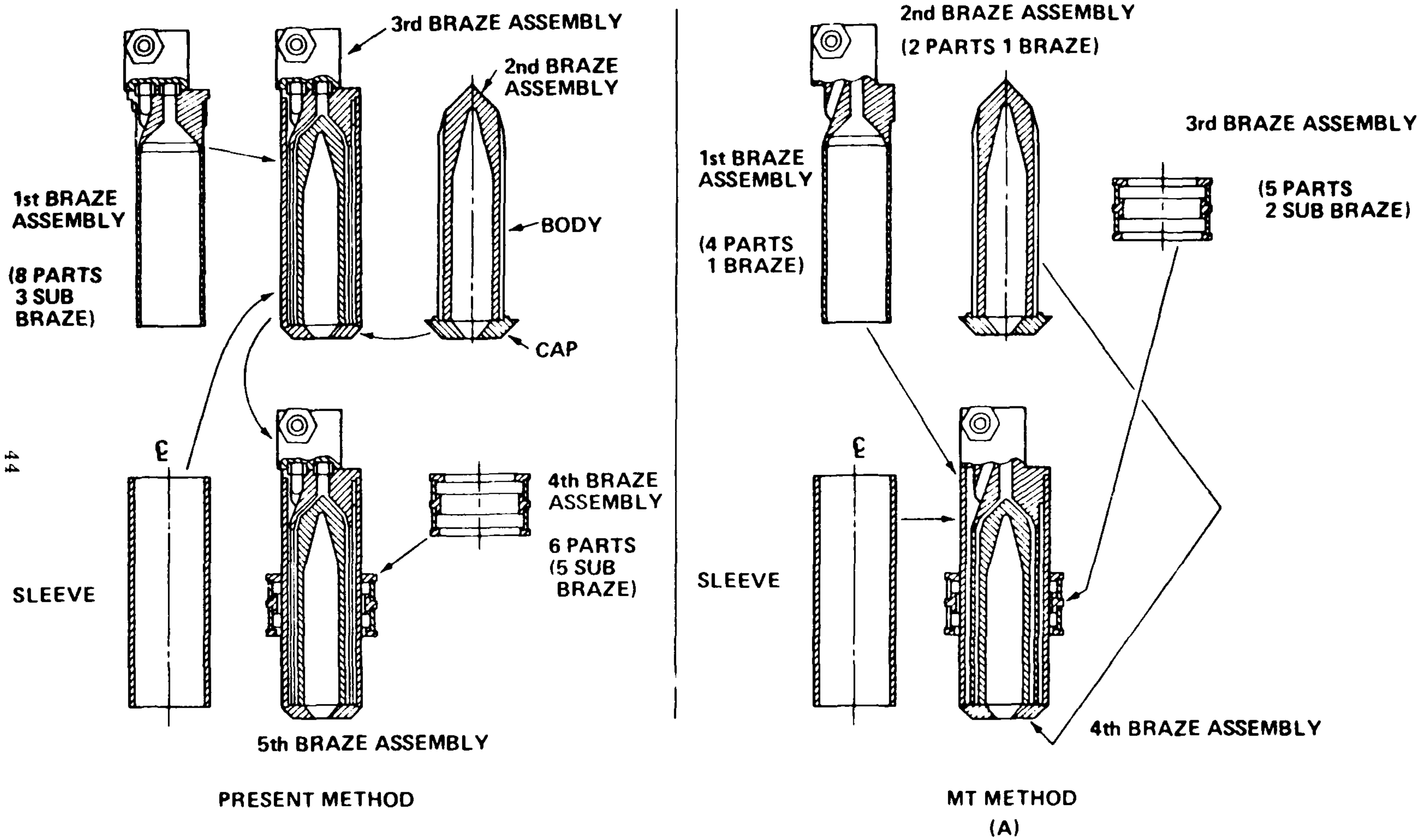


FIGURE 24. FINAL COLLECTOR ASSEMBLY

14. PARTS FOR TUNER ROD BRIDGE ASSEMBLY

To help lower the cost of the internal tuner assembly and reduce the labor content, Varian made changes to these individual parts that make up the tuner bridge rod assembly which is a subassembly of the internal tuner assembly. (See Section 15).

TUNER ROD

At present the tuner rod is machined with a smaller diameter step on one end. (See Figure 25). The new manufacturing method is to change the mating part tuner bridge and centerless grind a length of rod and cut pieces off to length. (See Figure 25 A).

TUNER BRIDGE

Currently six .020" diameter holes are machined. (See Figure 25). The new method will have the .100" deep holes and two of the .020" diameter lock pin holes machined to a .032" diameter hole. (See Figure 25 A).

TUNER BODY

At present the tuner body has four .020" diameter holes machined. (See Figure 25). The new method will have all four holes machined to .032" diameter. (See Figure 25 A).

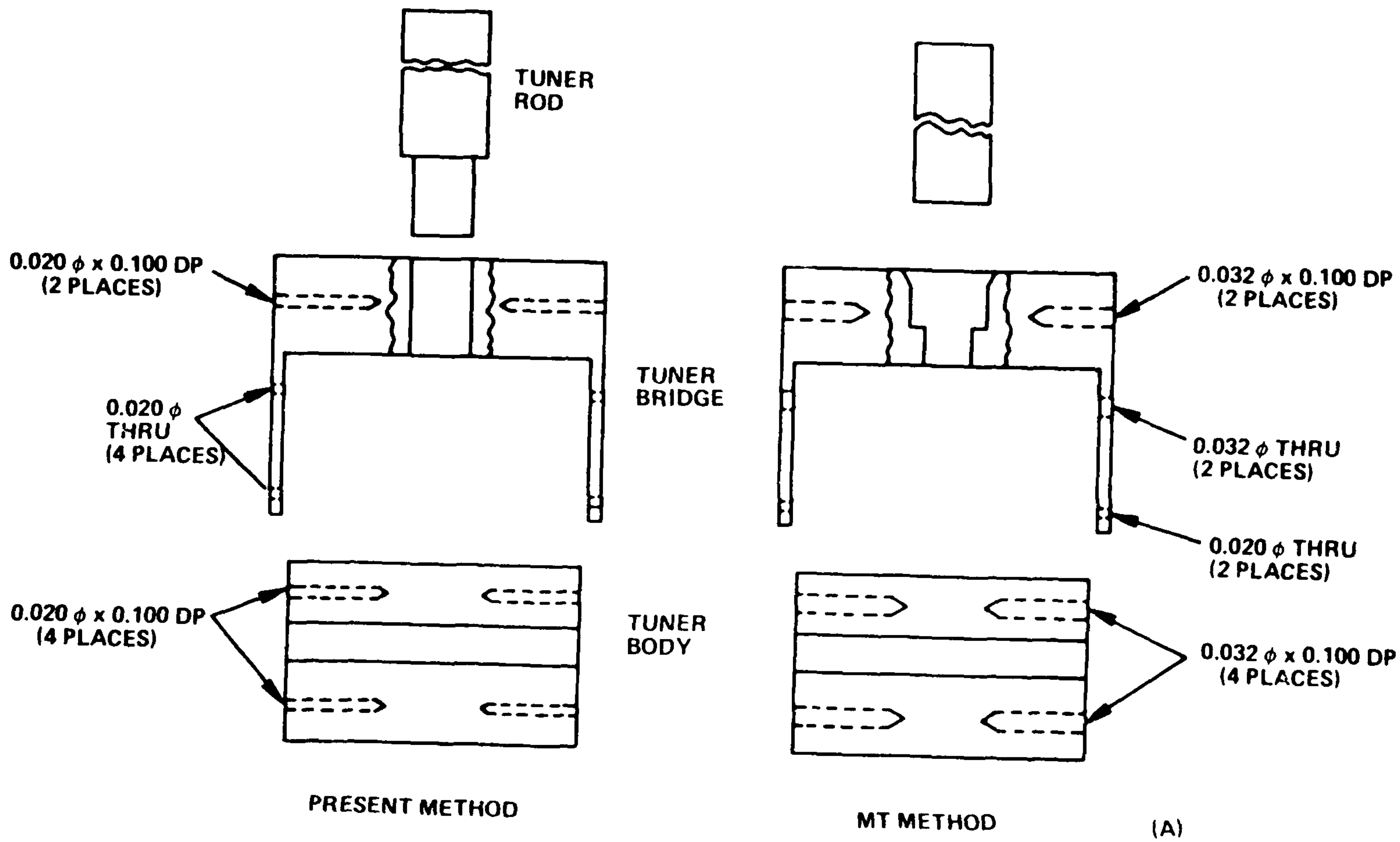


FIGURE 25. TUNER ROD BRIDGE ASSEMBLY

15. INTERNAL TUNER ASSEMBLY

Engineering evaluated the internal tuner assembly with the intent of reducing assembly labor and providing a simpler assembly method which would also produce a higher yield.

PRESENT METHOD - VKU-7785E

The current assembly as shown in Figure 26 is as follows:

1. Assemble tuner rod to tuner bridge (See Figure 25)
2. Braze and inspect
3. Assemble five bellows assemblies, two nuts, tuner plate and heliarc ring
4. Braze and inspect
5. Assemble five tuner rod bridge assemblies into the bellows and braze as an assembly to the tuner plate assembly, then proceed with second braze of the five tuner rod caps to tuner rods.
6. The complete unit is then physically inspected for proper alignment and braze integrity.

This assembly and braze technique requires a triple piece part joint. A quality braze is difficult to obtain because the braze material flows away from the rod cap due to gravity. It is also difficult to maintain the required alignment of the rods and bridge assemblies to the center line of the bellows. This alignment is critical to the smooth operation of the internal tuning mechanism.

MT METHOD - VKU-7785F

The new assembly method changes the assembly sequence and reduces total braze operation to two. (See Figure 26 A). In order to accomplish this, Engineering has designed new brazing and assembly fixtures and redirected new assembly procedures as follows:

1. Assemble tuner rod cap, bellows and tuner rod
2. Braze and inspect
3. Assemble five rod cap bellows assemblies into the tuner plate with five tuner bridges, heliarc ring, and two nuts

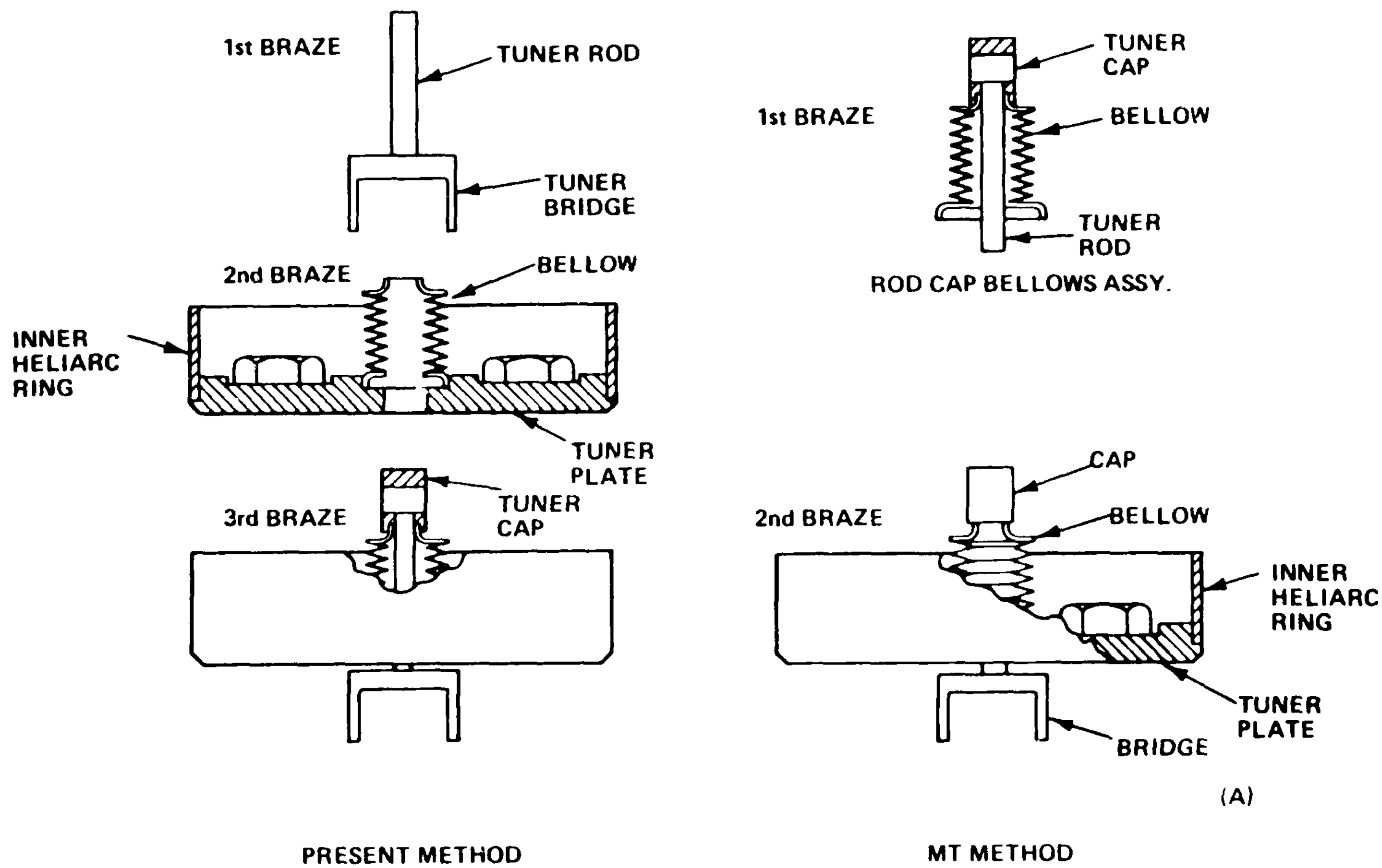


FIGURE 26. INTERNAL TUNER ASSEMBLY

[illegible]. Braze and inspect.

Engineering has provided a new fixture that will ensure better alignment of the bridge to the tuner rod and has engineered this fixture to provide a continuous, constantly controlled pressure on parts to allow for expansion during the braze operation.

New fixtures also allow a gravity braze in the direction of the braze joint and capillary flow of the braze material into braze joints. The reliability and integrity of the mating of rod cap and bellows has been greatly enhanced. This has improved the vacuum integrity of this joint in addition to reducing stress created by any misalignment.

The new assembly sequences have, through combined braze operation and improved tooling and braze fixtures, greatly improved the yield, reduced labor and assembly time.

16. CATHODE MAGNET POLEPIECE

Changes in the fabrication method of this part have reduced material cost, handling, and machining operations.

PRESENT METHOD - VKU-7785E

The cathode magnet polepiece is hogged from a 4.5" diameter bar which has been rough cut to length. (See Figure 27.) This piece weighs 13.5 pounds. After the two rough machine operations are completed the part is chemically cleaned, then taken to the furnace room where an annealing operation removes stresses. The part is returned to the machine shop for final machining operations.

MT METHOD - VKU-7785F

This part will be purchased as a 2 1/2" diameter forged blank which has been normalized. (See Figure 27 A.) This blank weighs 6.8 pounds, which represents a cost reduction by reducing material cost, machining, chemical cleaning and annealing operations. The only remaining operation is machining to final dimensions. This new method eliminates excessive handling, processing, and transporting of parts.

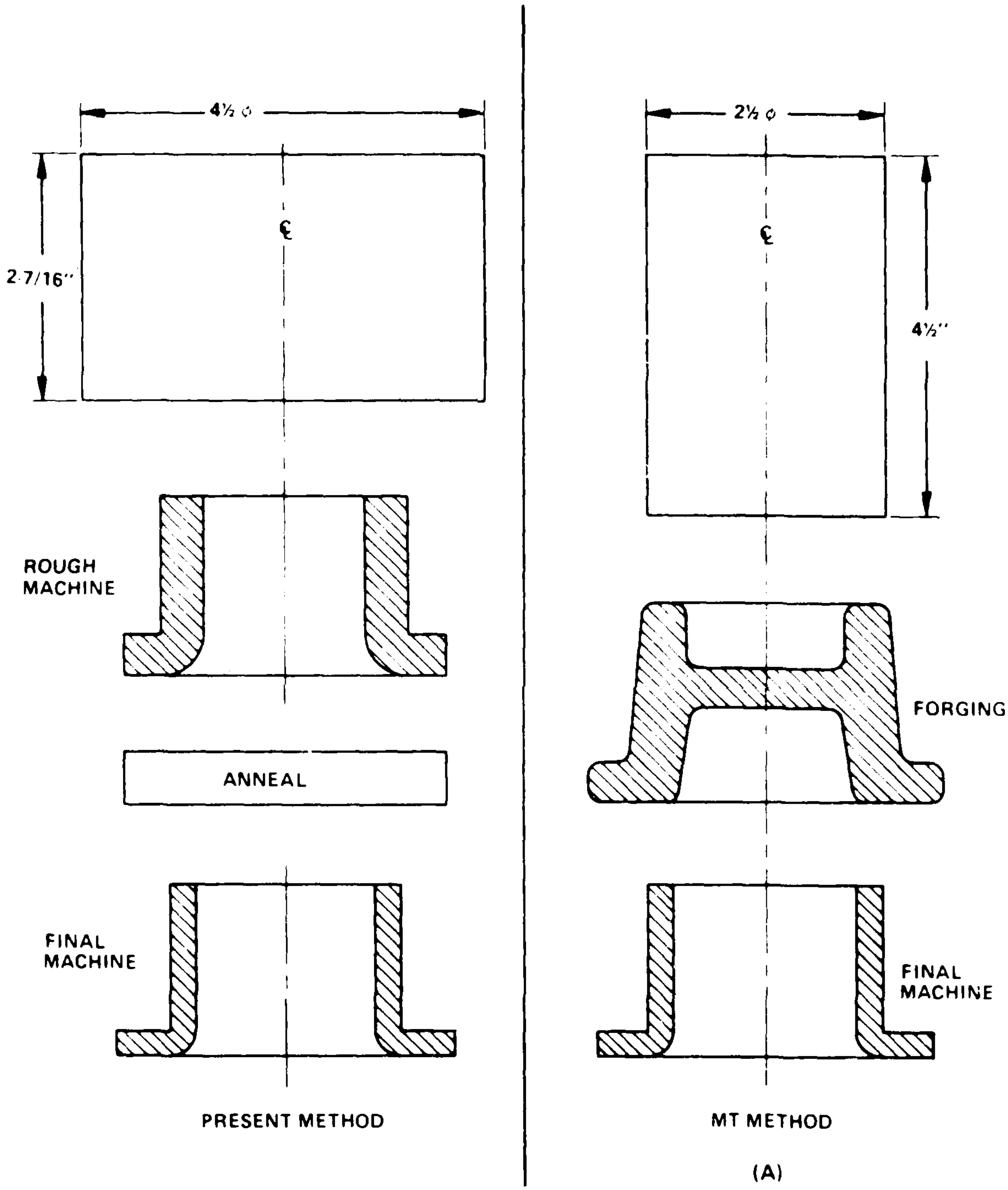


FIGURE 27. CATHODE MAGNET POLEPIECE

17. ELECTRON GUN AREA

Miscellaneous Processing Changes

In order to simplify the assembly operations in the electron gun area and to provide a more efficient transfer of heat from the cathode assembly, Engineering has made several refinements in this area. The MT methods and techniques reduce assembly time, eliminate potential stress conditions on the BeO ceramic disc which mounts on top of the heat sink strap, which in turn provides a more efficient heat transfer from the cathode into the cooling fin assembly. In order to clarify the MT changes both the present and proposed methods will be discussed concurrently.

The present two-piece overlapping heat sink strap has been replaced with a one-piece heat sink strap which allows direct metal-to-metal contact of the cathode support post to the larger heat sink washer. (See Figure 28.) This eliminates two metal-to-metal interfaces in the heat sink path which reduces thermal transfer characteristics. The larger heat sink washer was modified to accept a flat head countersunk screw which allowed the flush seating of the BeO ceramic insulator on the large heat sink washer again improving the thermal characteristics. The BeO ceramic, (Figure 29), was modified to eliminate the center hole since the flat head screw would be flush with the top surface of the large heat sink washer and does not project through the center hole of the BeO ceramic and into the center hole of the cathode cooling fin assembly.

The improvements of the large heat sink washer, the BeO ceramic and the elimination of the projection of the center bolt into the ID of the cathode cooling fin has also eliminated a molding step since no high voltage potting material is required to isolate the center bolt (25 kV operating from the cooling fin, ground potential).

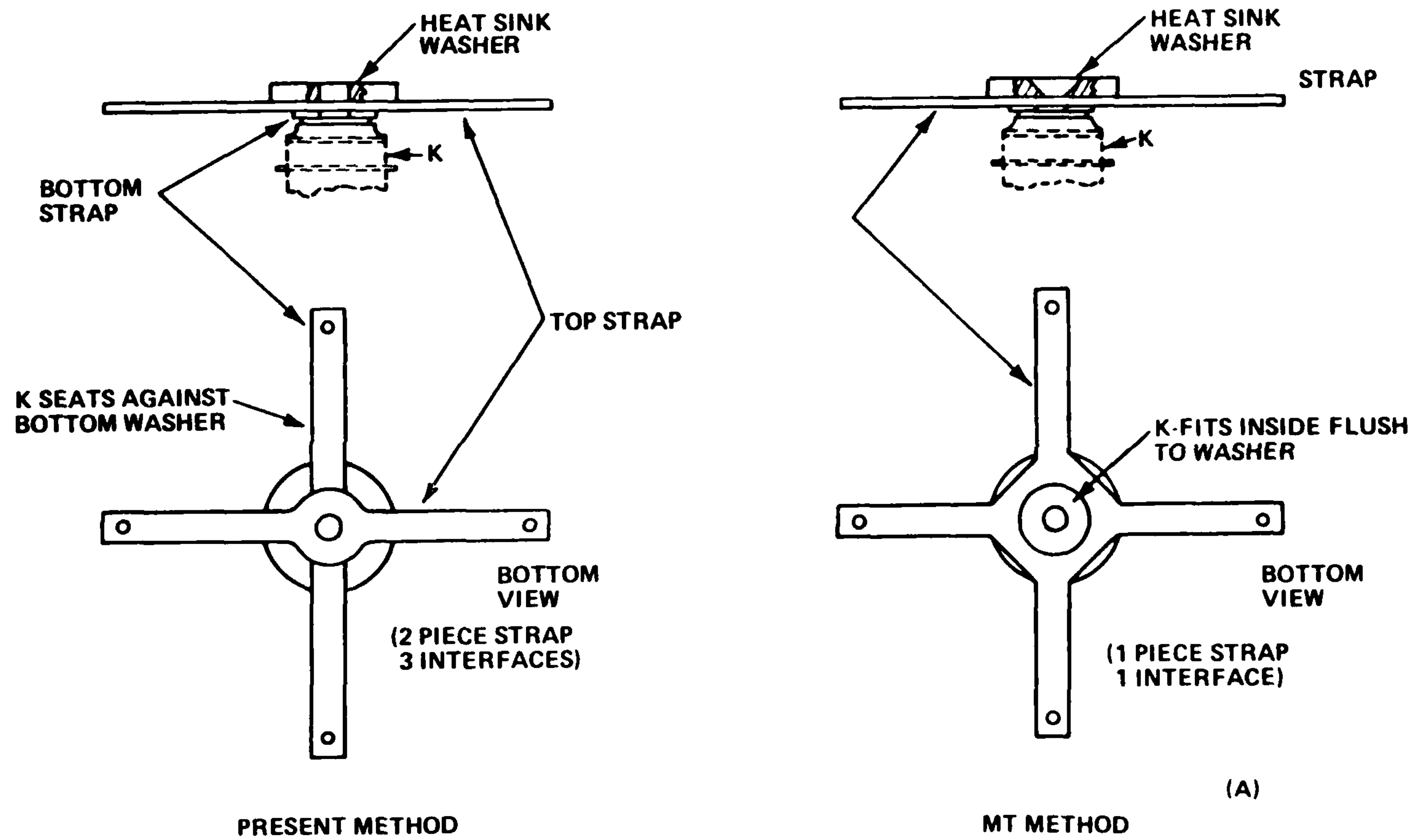


FIGURE 28. HEAT SINK STRAP ASSEMBLY

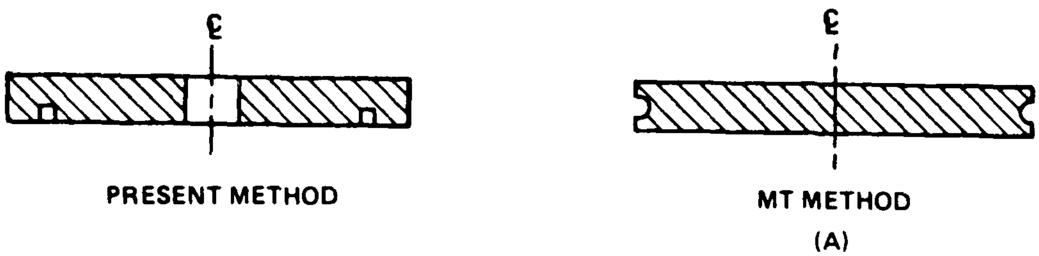


FIGURE 29. CATHODE INSULATOR BeO

The labor and handling time required to assemble and align the cooling radiator to the cathode polepiece is reduced with the new assembly method. In addition, the parallelism of these three assemblies has been improved, thereby, reducing the potential of uneven mechanical stress on the BeO ceramic insulator.

18. COOLING FIN ASSEMBLY

In the studies of various ways to reduce processing times on the klystron, Engineering investigated the cooling fin assembly which conducts heat from the cathode assembly.

PRESENT METHOD - VKU-7785E

The present configuration of the cooling fin assembly is comprised of three machined parts, the cooling fin, plate, and high voltage lead hold-down bracket. Each part has a number of various size tapped and through holes which are used to bolt the parts together. The cooling fin assembly has two trepan internal undercuts, used to anchor the potting compound necessary for high-voltage insulation (See Figure 30). The cooling fin and bracket assembly is ultimately bolted to the cathode polepiece through four standoffs.

The cathode heat is transferred from the cathode through the heat sink washer, a BeO ceramic disc, into the cooling fin assembly, and out into the surrounding air.

MT METHOD - VKU-7785F

Engineering had proposed that the ultimate cooling fin assembly and bracket be made from a one-piece investment casting, thus eliminating the machining from a solid piece of aluminum and a number of close-tolerance drilled and tapped holes. The cast part was to be purchased from an outside supplier which required an initial tooling expense. After a number of one-piece castings were received for Engineering evaluation, it was evident that although they were dimensionally correct, the variations in alloy content made them unsuitable for this application.

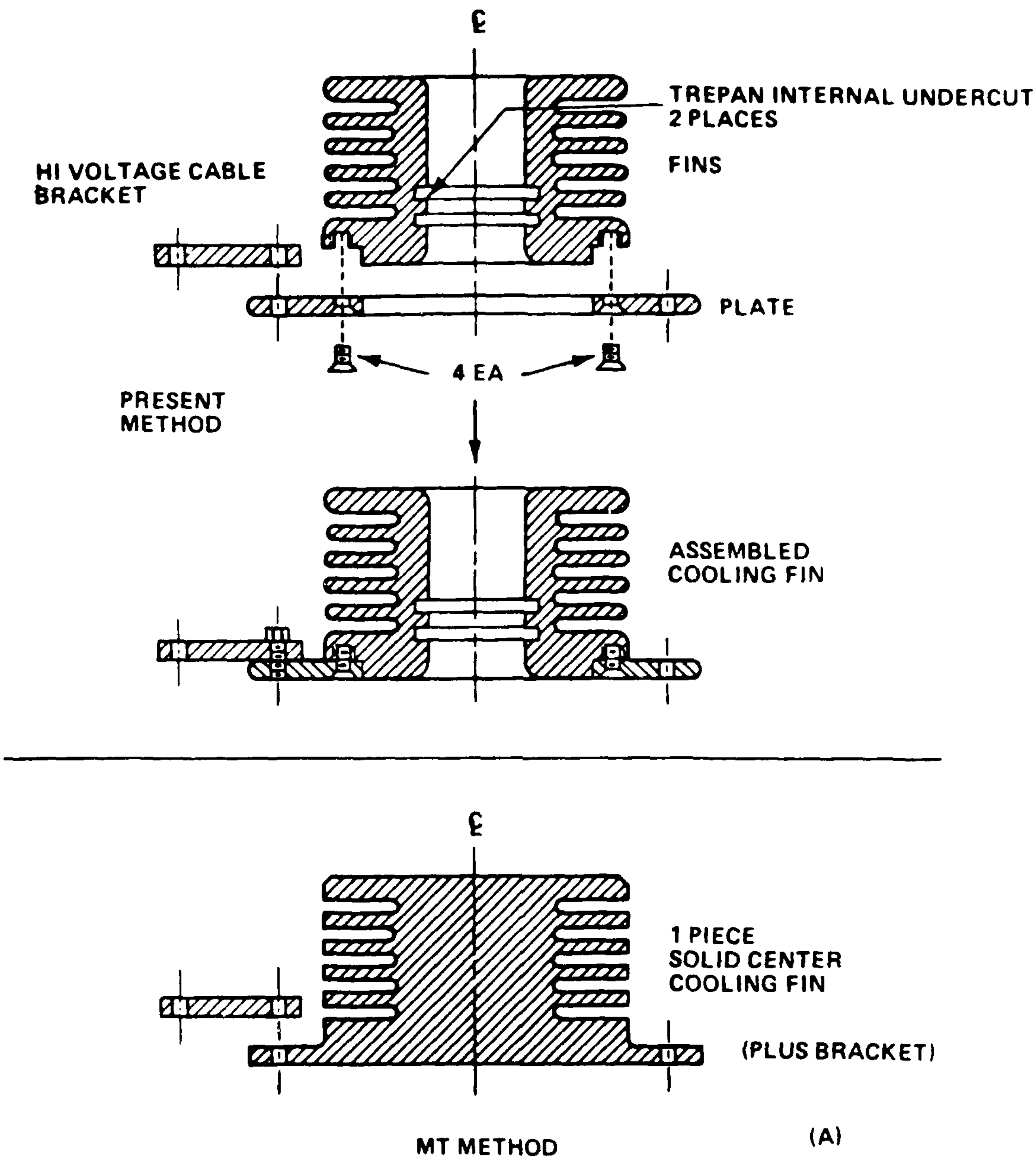


FIGURE 30. COOLING FIN

Engineering decided to reinvestigate other tooling techniques and to eliminate the center hole and the two trepan internal undercuts. (See Figure 30 A.) With special form tooling, the cooling fin assembly was made in a single operation. This simplified machining process, using a multiple point form tool, was less expensive than the combination of investment casting techniques with minimum machining.

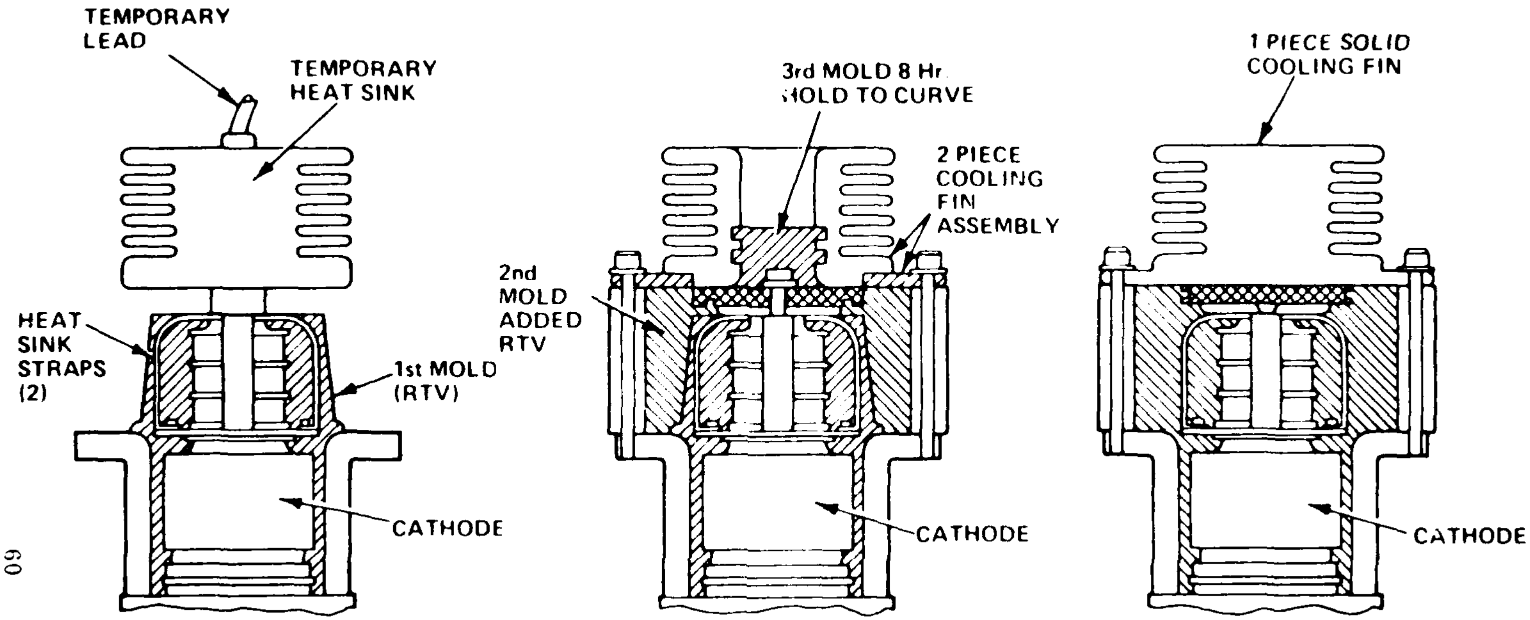
19. CATHODE POTTING/MOLDING PROCESS

Engineering, in their evaluation of ways to reduce handling and improve the process techniques, has investigated new potting techniques and materials which would improve the method of processing the tube and still provide adequate cathode insulation on the klystron. Representatives of Dow Corning were contacted and several new potting materials were tried in engineering evaluation tests. A new potting material which meets the ultimate tube voltage standoff requirements and the required military specifications has been tested and accepted for use by Engineering.

PRESENT METHOD - VKU-7785E

The present fabrication method is to attach three temporary leads to the cathode/grid structure. The structure is then potted with enough potting to insulate the operating voltage (26 kV) from ground during first test of the tube. This first molding operation requires an 18-hour hold period for the RTV to properly cure. It was determined that pouring the entire RTV molding in one operation was too thick and did not cure properly. Temporary leads were installed for first test because the price of the final cable assembly was too expensive and if the cable had to be removed for any reason the lead lengths would not allow additional attachments to the cathode. After an acceptable first test, the tube is returned to the final dress area, and the temporary potting and leads are removed.

The high voltage cable which includes the final connector is then attached to cathode/grid structure followed by a second potting and another cure cycle of 18 hours. The tube is then second tested to assure no changes have occurred to the electrical parameters of the tube and then returned to the finishing area for the third and final pour with an 8-hour cure cycle. The tube is then tested to the final acceptance test procedures. (See Figure 31.)



1st ASSEMBLY

TEMPORARY LEADS
TEMPORARY COOLING FIN
POUR 1st MOLD (RTV) (HOLD 18 Hrs)

TEST

2nd ASSEMBLY

ASSEMBLY PERMANENT LEADS
LARGE HEAT SINK WASHER
BEO CERAMIC
SMALL HEAT SINK WASHER
CENTER SCREW

POUR 2nd MOLD (HOLD 18 Hrs.)
ASSEMBLE COOLING FIN ASSEMBLY
POUR 3rd MOLD (RTV) (HOLD 8 Hrs.)

TEST

PRESENT METHOD

1st ASSEMBLY

ASSEMBLE ONE PIECE HEAT SINK STRAP
HEAT SINK WASHER
CENTER BOLT
BEO CERAMIC

POUR MOLD COMPLETE RTV (18 Hrs.)
ASSEMBLE ONE PIECE COOLING FIN

TEST

(A)

MT METHOD

FIGURE 31. CATHODE MOLDING PROCESS

MT METHOD - VKU-7785F

After extensive Engineering evaluation of different potting materials and cure cycles under simulated operating conditions. Engineering approved a suitable RTV which can be poured and cured in one operation with only one 18-hour hold period. The new potting permits attachment of the final cable assembly prior to first test. The customer has approved additional service length to the cable which could allow additional rework, and use of the cable assembly, if required. This new technique reduces the handling, extensive preparation at first and final dress operations, eliminates two molds and the associated potting cycles, as well as the time required to cure the RTV. The quality of voltage holdoff characteristics and of the overall assembly has been greatly enhanced. (See Figure 31 A.)

[illegible]. SEAL ASSEMBLY

Engineering studied ways to improve techniques associated with the klystron manufacturing methods program and prompted them to investigate new techniques of assembling the mechanical tuner assembly to the tube body assembly. One of the more difficult assembly operations, from the standpoint of possibly causing damage to the tube, was installing the rubber seal assembly over the tuner assembly. This boot is to provide environmental protection of the mechanical tuner mechanism and the [illegible] tuner assembly.

PRESENT METHOD - VKU-7785F

The seal frame assembly has a finished thickness of .0[illegible]" ± .005" with surface A and surface B flat and parallel to each other. The seal frame material is stainless steel. The seal frame holds the rubber boot in place and insures the integrity of the rubber boot seal to the mechanical tuner assembly. The seal and boot assembly assists in the protection of the delicate tuner mechanism and helps to withstand the ultimate operational environment.

In order to assure a tight seal to the mating external mechanical tuner assembly which is directly mounted on the body assembly, the technician, with the aid of a special tool, is required to delicately push the lip of the silicone rubber seal over the outer heliarc ring of the external mechanical tuner assembly (much like putting a tire on an automobile rim). If the tool should slip during this assembly procedure there is a strong possibility of damaging the tuner bellows and possibly allowing the tube vacuum envelope to go down to air. If this occurs, a major rework and repair would be required with many additional man hours and material involved, (Figure 32).

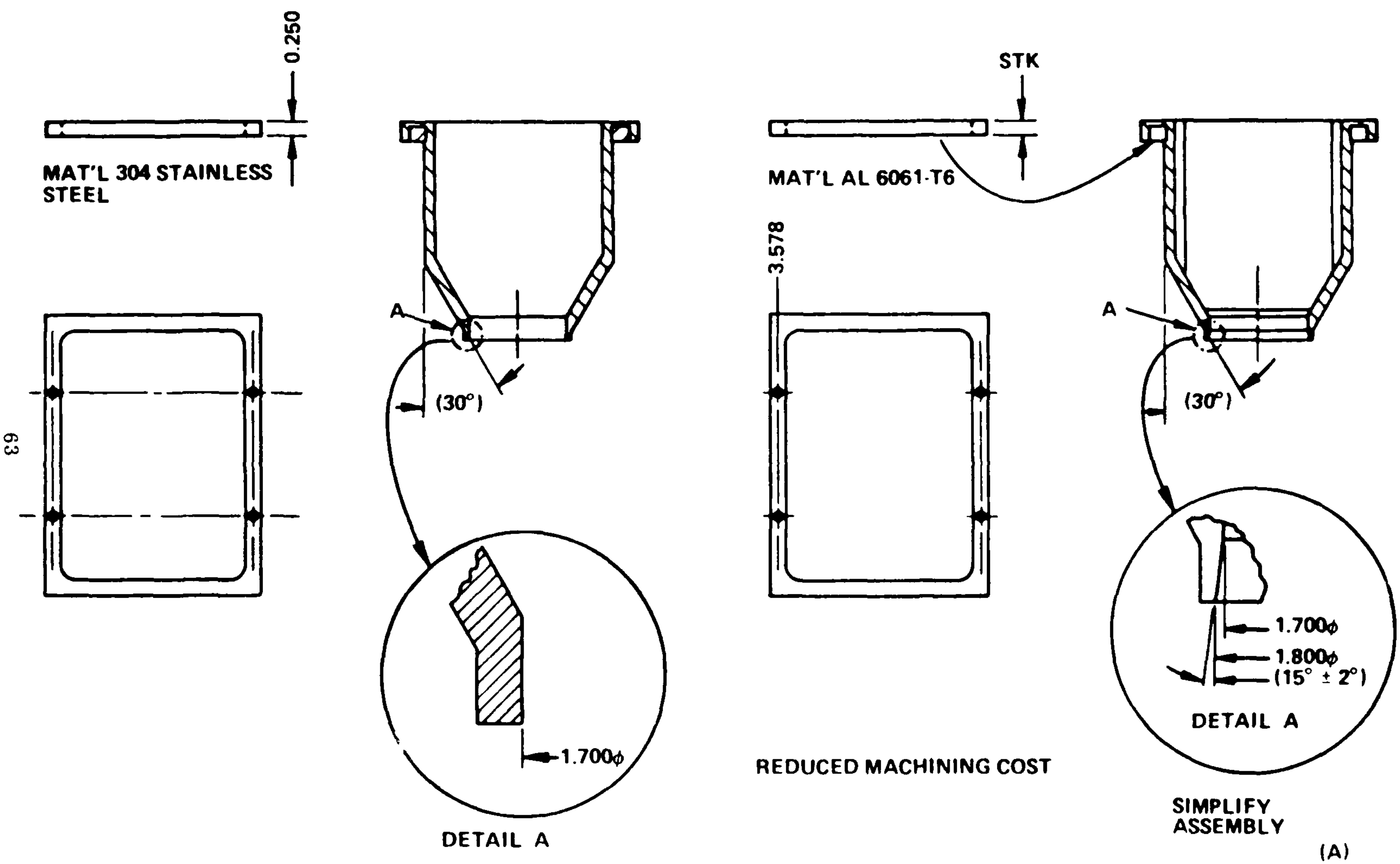


FIGURE 32. SEAL ASSEMBLY

MT METHOD - VKU-7785F

The seal frame is made from stock thickness wrought aluminum alloy. This eliminates the need of the two-sided machining operations and still provides the environmental integrity and the hold-down characteristics of the rubber boot seal to the mechanical tuner assembly.

The silicone rubber boot mold has been changed to provide a 15° lead angle with additional thickness and stiffness at the lip where it fits over the tuner heliarc ring. This provides the operator with a much quicker and less troublesome mating operation with the outer heliarc ring, and eliminates the potential damage to the fragile bellows assembly. The required skill of using the special mating tool has been eliminated. All this ultimately leads to a reduction in labor and cost of fabrication. (See Figure 22 A.)

21. SWITCH CAM ASSEMBLY

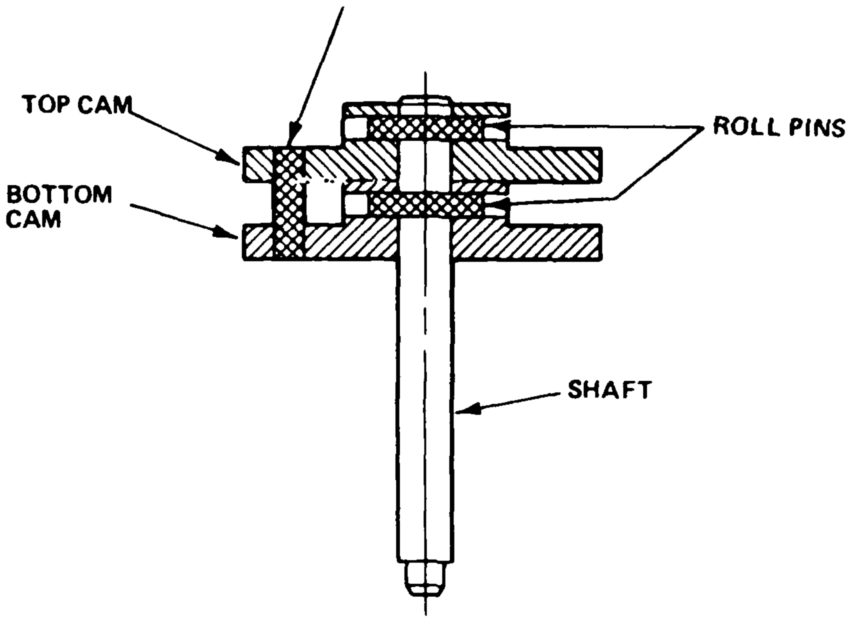
To reduce the assembly time and piece part costs Varian will now manufacture the two cams as a single cam.

PRESENT METHOD - VKU-7785E

Two gear blanks are purchased and modified to include cam notches and pin hole orientation. The modified cams are then pinned together and mounted to the cam shaft. (See Figure 33.)

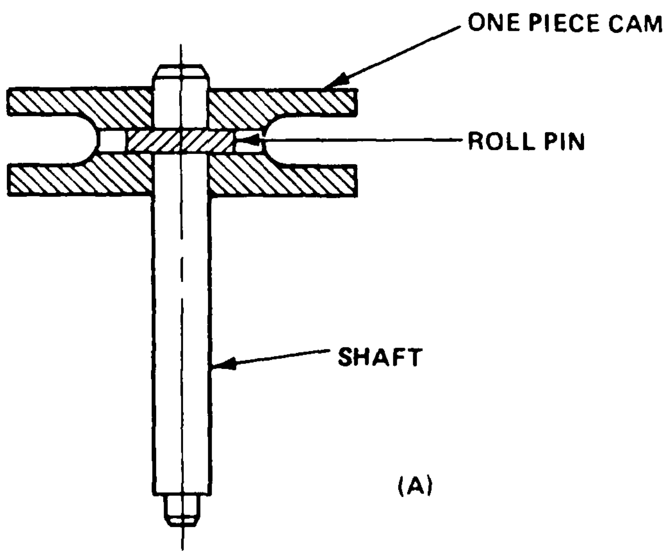
MT METHOD - VKU-7785F

The manufacturing of the two cams into a one-piece cam has resulted in reduced parts cost, a reduction in the number of parts, and the reduction of assembly labor by eliminating the orientation, pinning operation, and the mounting of two cams on the shaft. (See Figure 33 A.)



PRESENT METHOD

3 PARTS + 3 ROLL PINS



MT METHOD

2 PARTS ONE ROLL PIN

FIGURE 33. SWITCH CAM ASSEMBLY

22. LOCK/UNLOCK CAM ASSEMBLY

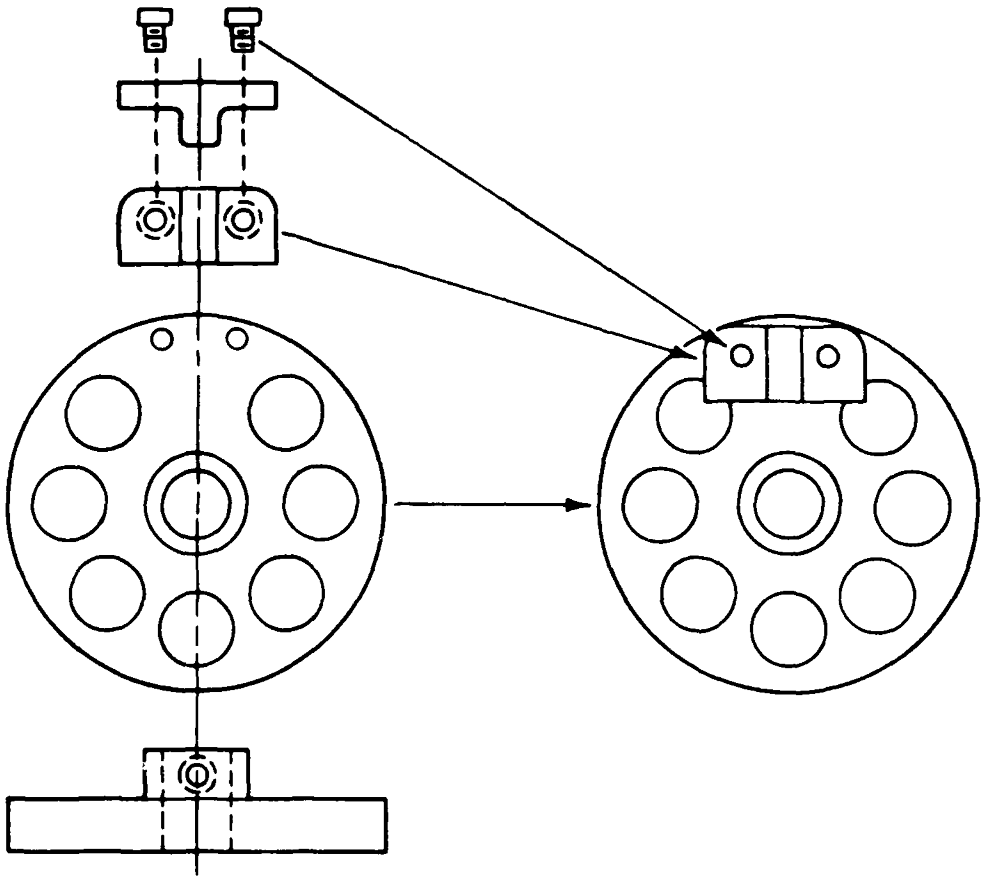
To reduce the assembly time, the number of parts, and parts cost, the lock/unlock cam assembly has been changed.

PRESENT METHOD - VKU-7785E

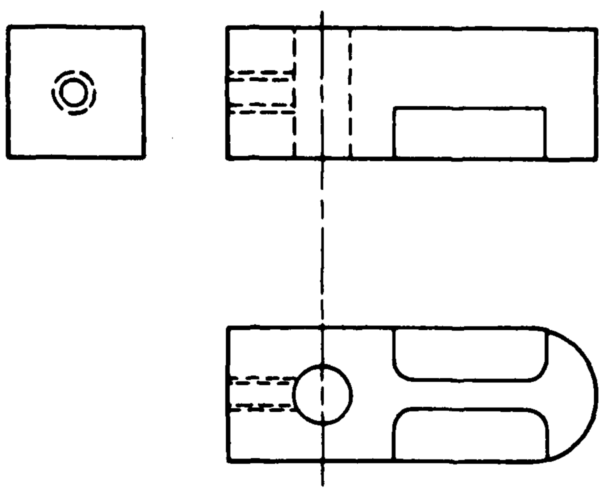
Varian purchases a gear blank, then proceeds to machine seven holes to lighten the weight of the part after which two holes are drilled and tapped. A machined cam block is assembled to the modified gear block. (See Figure 34.)

MT METHOD - VKU-7785F

The end result of the engineering change to the lock/unlock cam assembly is a smaller and lighter one-piece lever arm cam that eliminates the assembly labor and reduces the part cost. (See Figure 34 A.)



2 PIECES + 2 SCREWS
PRESENT METHOD



(A)

1 PIECE

MT METHOD

FIGURE 34. LOCK/UNLOCK CAM ASSEMBLY

23. SPRING HOUSING

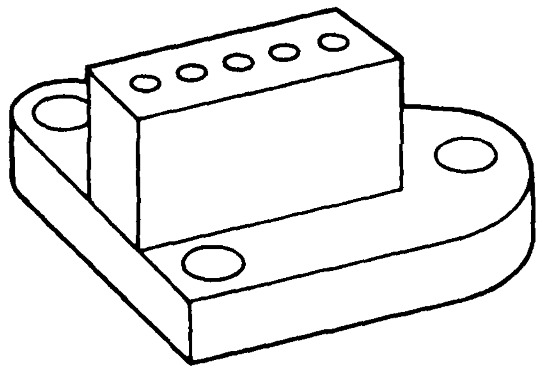
Engineering in their evaluation of all assemblies which make up this tube, naturally evaluated other techniques for attaining the desired result. One of these parts which was investigated is the spring housing which preloads the tension on the internal tuner bobbins and the channel adjustment screws.

PRESENT METHOD - VKU-7785E

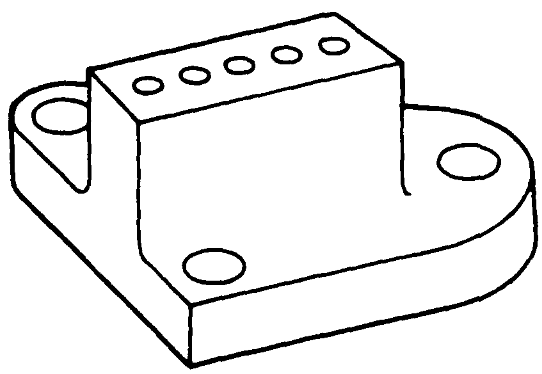
The present method is to hog the part out of a one-inch aluminum plate. This requires the use of excessive material. Several machining operations and setups are required prior to obtaining the finished part. (See Figure 35.)

MT METHOD - VKU-7785F

The new part is a purchased investment casting. All machining and setup times are eliminated except the counterbores for the three bushing holes and countersinking the bushings. The initial procurement required the purchase of precision molds. (See Figure 35 A.)



PRESENT METHOD



SPRING HOUSING

MT METHOD

FIGURE 35. SPRING HOUSING

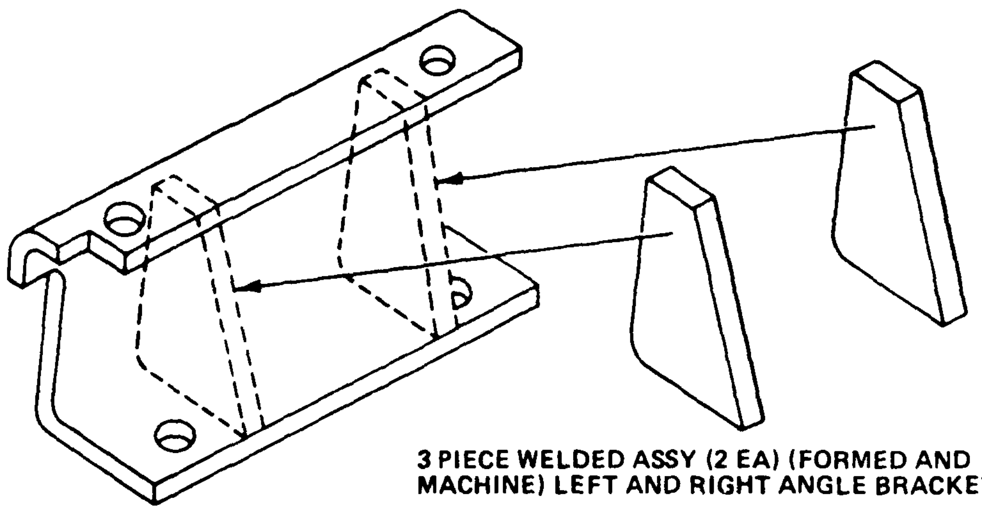
24. ANGLE BRACKET ASSEMBLY

PRESENT METHOD - VKU-7785E

The three pieces which make up the angle bracket assembly (two per tube) are sheared from 1/8" thick stainless steel sheet stock. One piece is then punched and formed to make the frame. The formed part and two gussets are welded together. (See Figure 36.)

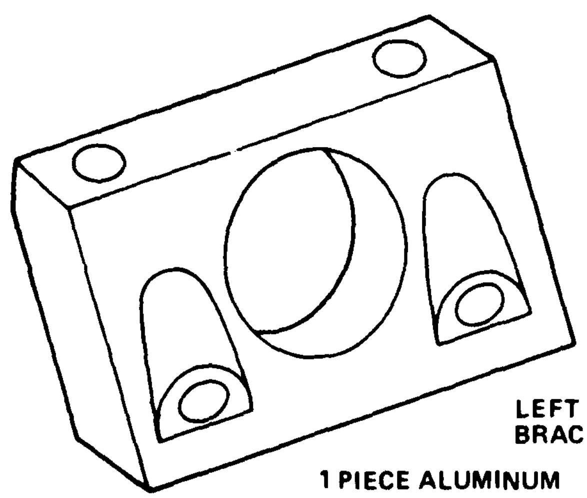
MT METHOD - VKU-7785F

The fabrication method of the angle brackets as shown in Figure 36 A allows very simple machining from one-inch aluminum plate, this reduces material and labor costs. The off setting of the mounting holes simplifies the mounting of the brackets to the tuner side mount bracket. Figure 39 shows the assembly of the angle bracket and the mounting brackets.



3 PIECE WELDED ASSY (2 EA) (FORMED AND MACHINE) LEFT AND RIGHT ANGLE BRACKETS SST

PRESENT METHOD



LEFT AND RIGHT ANGLE BRACKETS

1 PIECE ALUMINUM

(A)

MT METHOD

FIGURE 36. ANGLE BRACKETS – LEFT-RIGHT

25. MOUNTING BRACKETS

Varian has modified the manufacturing procedures to both the tuner side mounting bracket, and the waveguide side bracket to reduce cost, and to provide easier, simpler, assembly procedures.

<u>PRESENT METHOD - VKU-7785E</u>

The following manufacturing operations are required to produce the mounting brackets as shown in Figures 37 and 38.

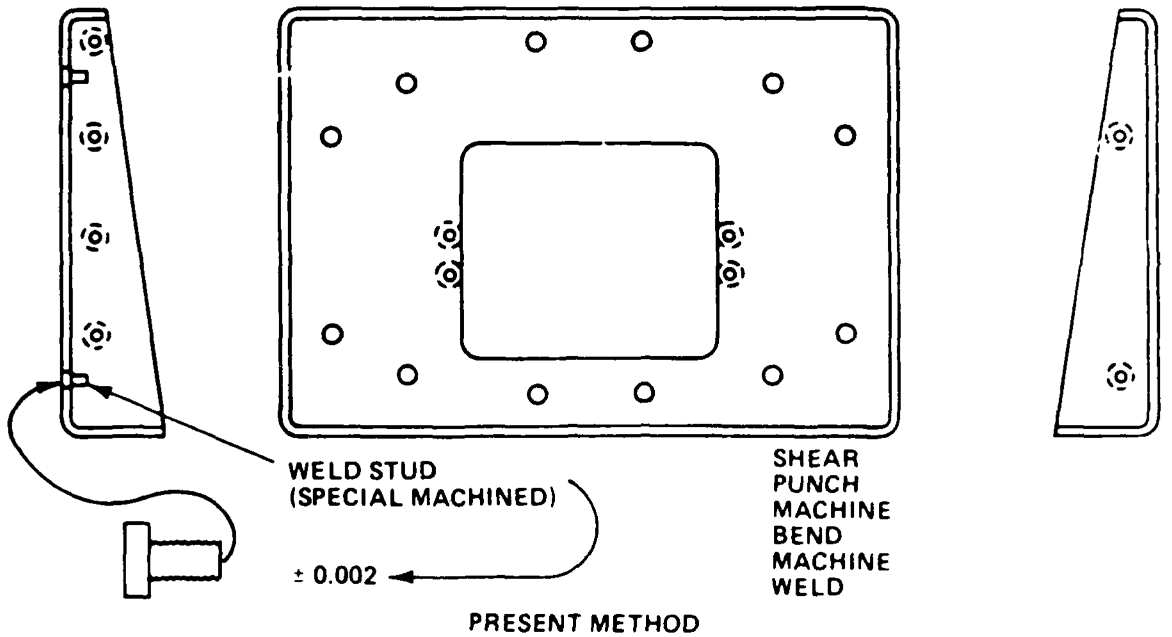
1. Shear sheets to size
2. Punch loose tolerance holes
3. Mill center openings
4. Drill close tolerance and small holes on sidewalls
5. Form the sides by use of a break
6. Weld corners
7. On tuner side only, (Figure 38) assemble mount bars with three bolts to mount bracket, to hold in place, then heliarc bars to mount bracket.

<u>MT METHOD - VKU-7785F</u>

Using special tooling and changing the manufacturing procedures reduces the cost, and improves the location accuracy of the mounting brackets. (See Figure 37 A and 38 A.) The new manufacturing methods are:

1. Blank and pierce all holes and openings with die set
2. Form sides on break using close tolerance location fixtures
3. Machine small holes on side

In addition, the new design allows the manufacture of both tuner side bracket and the waveguide side mounting bracket using the same tooling. Both support bars, the assembly operation of the mount bars to mount bracket, a number of holes and the heliarc welding operation have been eliminated. Figure 39 shows the assembly of the mounting brackets and the angle brackets.



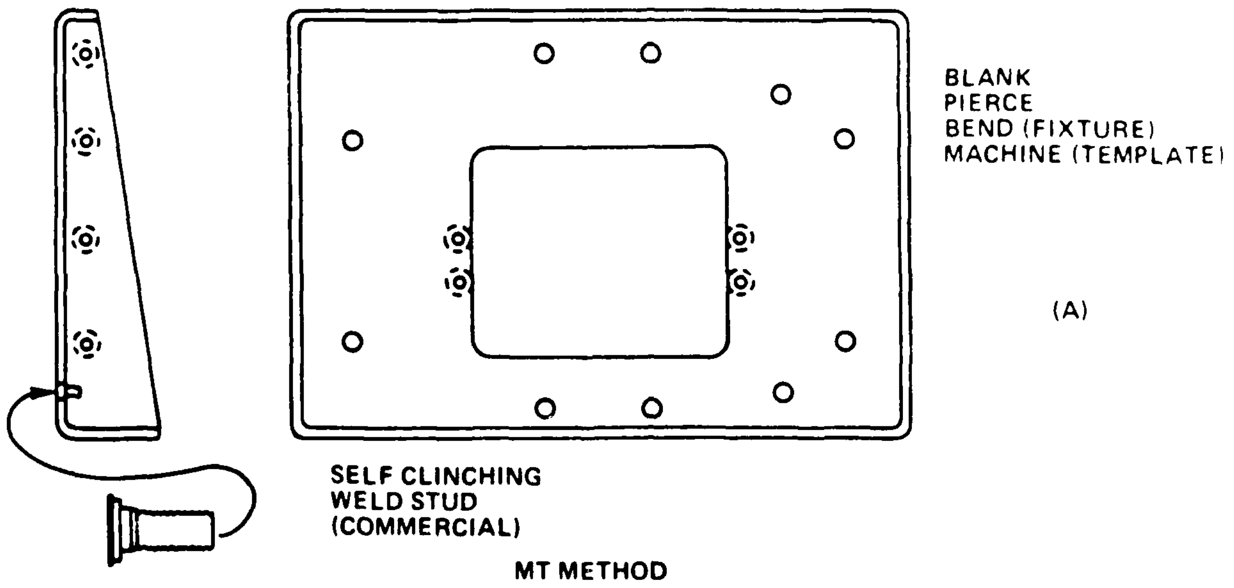


FIGURE 37. MOUNTING BRACKET WAVEGUIDE SIDE

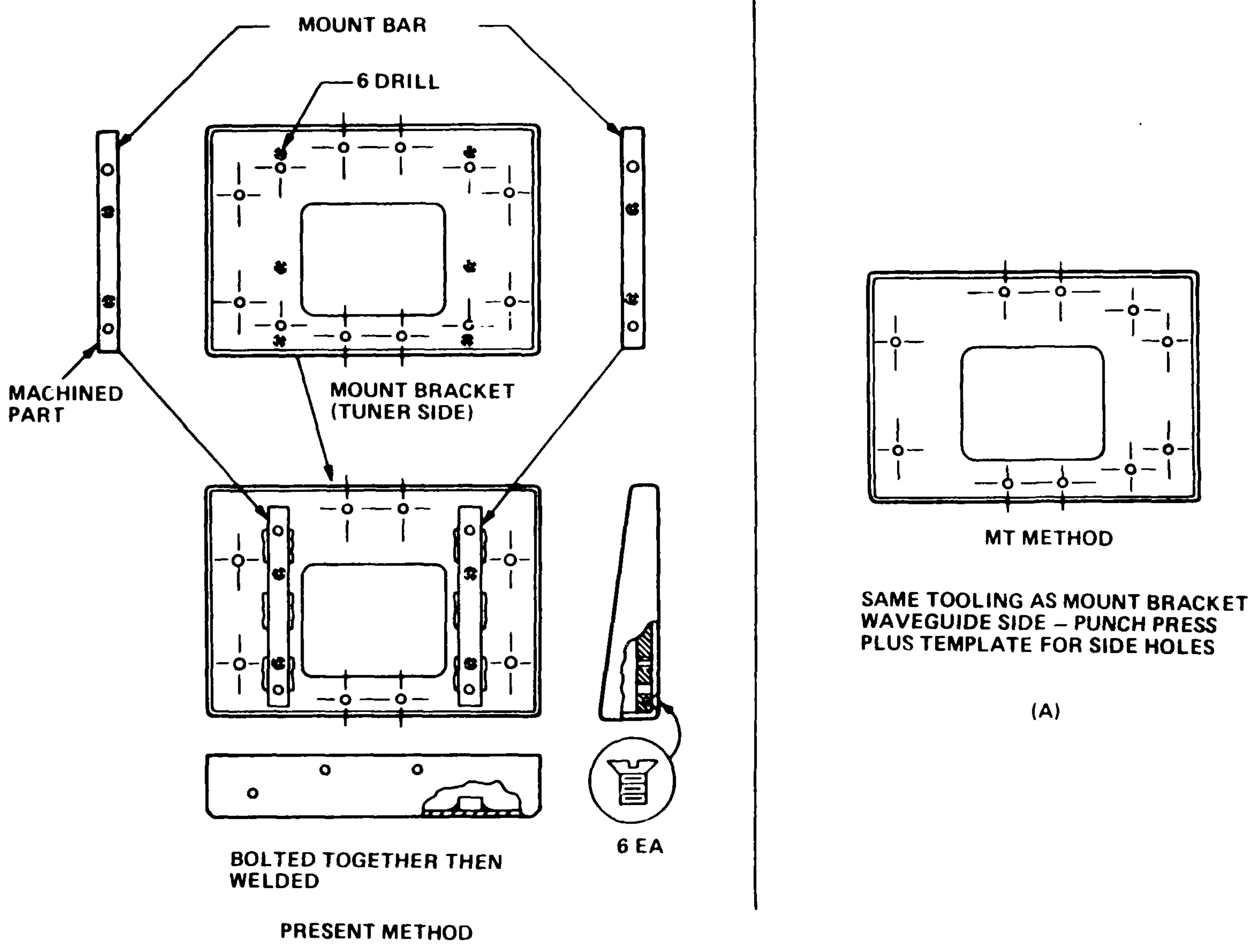
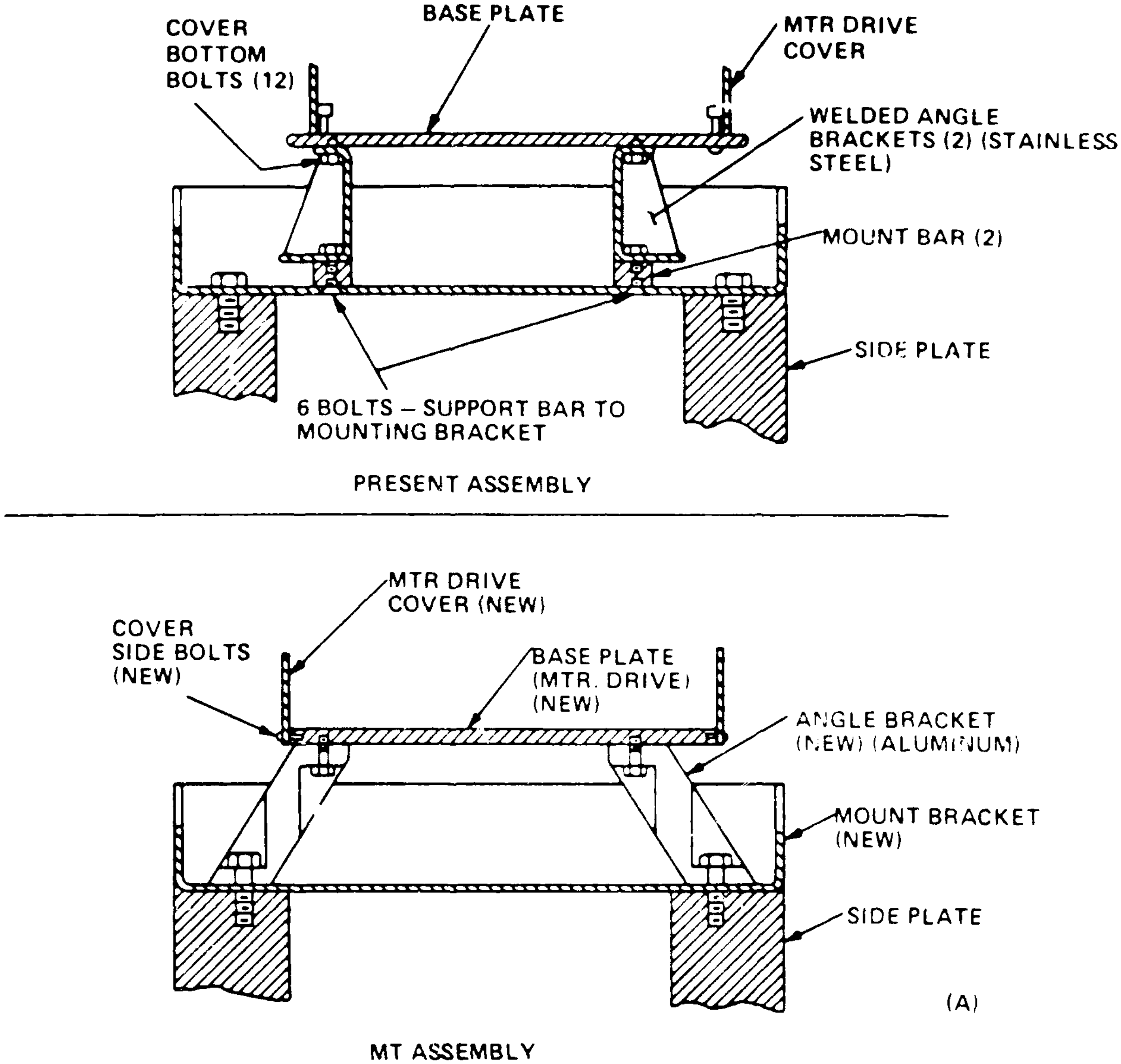


FIGURE 38. MOUNT BRACKET (TUNER SIDE)



1. OMIT BOTH MOUNTING BARS
2. SMALL BASE PLATE – EASIER ACCESS
3. ONE PIECE MACHINED ANGLE BRACKETS IN PLACE OF 3 PIECE WELDMENTS
4. DIRECT MOUNTING TO SIDE PLATES RATHER THAN TO MOUNT BRACKETS
5. SIDE BOLTS – COVER TO BASEPLATE RATHER THAN UNDERSIDE BOLTS

FIGURE 39. MOUNTING BRACKETS AND ANGLE BRACKETS

26. MOTOR DRIVE COVER

Engineering modified the cover to reduce assembly time, increase yield, and to provide more clearance for assembly of the cover to the motor drive unit.

PRESENT METHOD - VKU-7785E

The motor drive cover is assembled to the motor drive baseplate by inserting ten bolts from the bottom side of the baseplate, engaging them into the nut plate attachments on the inside surface of the cover. The space between the motor drive baseplate and the mount bracket provides a very restricted access in which to engage and tighten the ten bolts, as shown in Figure 40. The technician also has very limited vision when lowering the cover over the motor drive assembly. Excessive time and care must be taken to avoid damaging the internal wire harness of the motor drive assembly by snagging with the nut attachments on the inside of the cover.

MT METHOD - VKU-7785F

Varian modified the baseplate with an "O" ring seal and threaded holes along the baseplate sides. This allows the cover to be mounted with bolts through the sides of the cover onto the baseplate. The ten nut plates on the inside cover wall have been removed, which eliminates the potential damage to the wire harness and also provides more uniform and integrity of the anodizing process. This eliminates considerable time and improves throughput. (See Figure 40 A.)

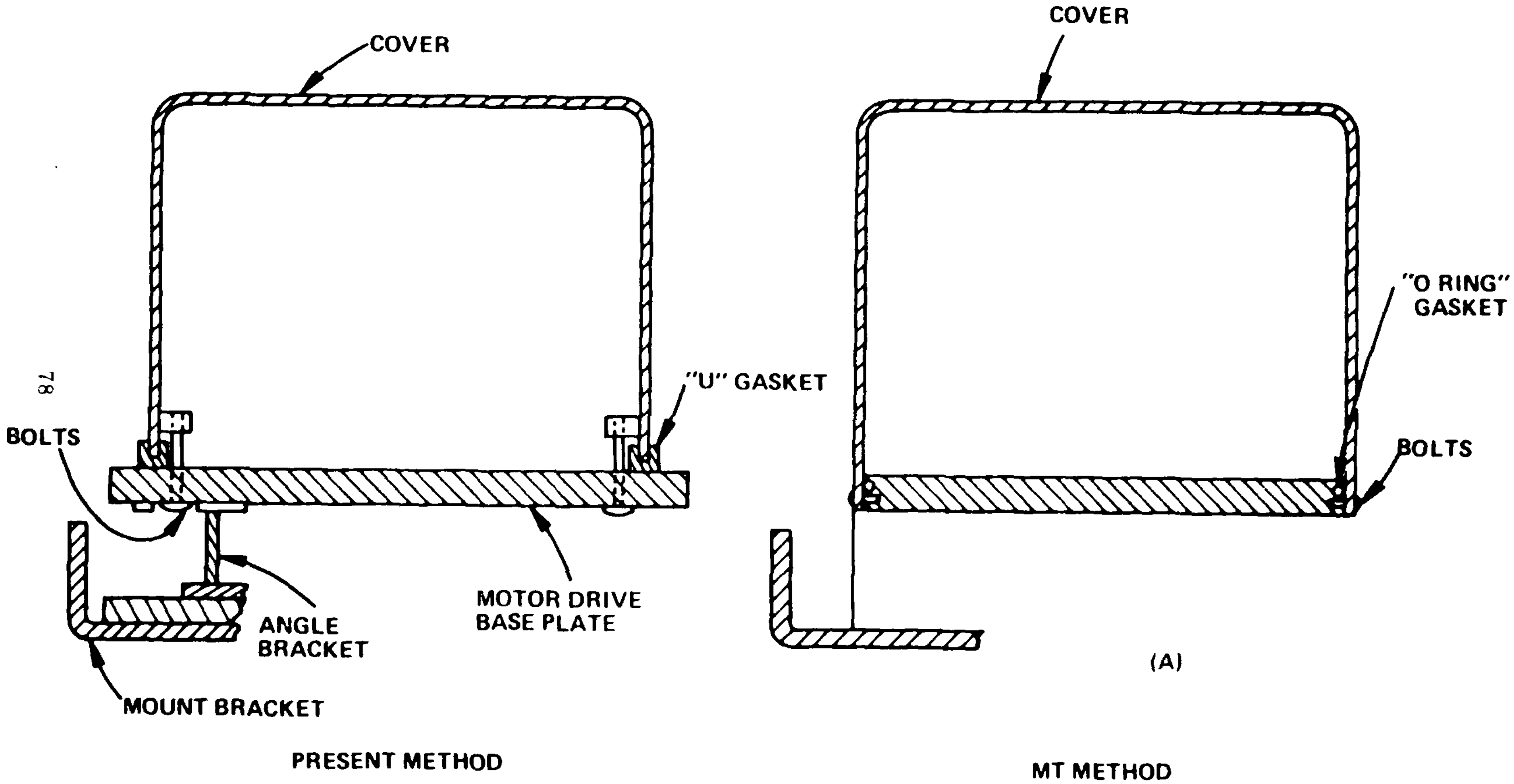


FIGURE 40. MOTOR DRIVE COVER

27. MISCELLANEOUS PARTS

In keeping with the intent of an MT Program, Engineering has made a thorough study of all parts which are used in the manufacture of the MT power klystron and autotuner assembly. The following is a compilation of several minor changes that have taken place as a result of these studies:

Tuner Cam Plate - Currently, Varian machines each plate individually and then inserts the thirty helicoils by hand. With the MT Method cam plates are now fabricated on a CNC controlled milling machine which handles up to ten plates at a time. New tooling and fixturing then permits automatic strip-fed helicoil insertion. (See Figure 41 and 41 A.)

Lock/Unlock Gear - Varian presently machines the Lock/Unlock Gear from a purchased gear blank in three steps: (Figure 42)

Step 1. Remachine the center bore

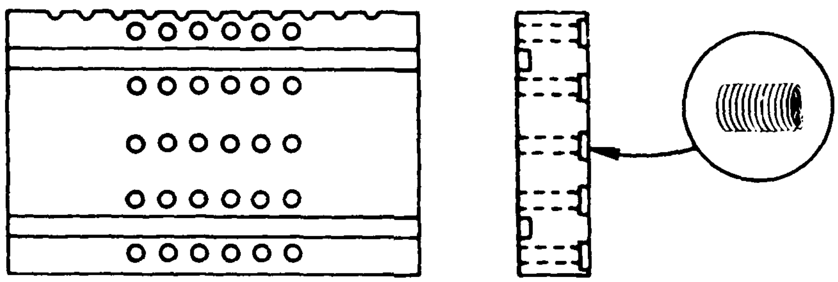
Step 2. Machine the slot

Step 3. Machine the eight lightening holes

Under the MT concept, Engineering uses the gear blank as it is received and does not rebore the center hole. The slot is still machined and the number of lightening holes reduced from eight to four. The part is lighter without any reduction in reliability. (See Figure 42 A.)

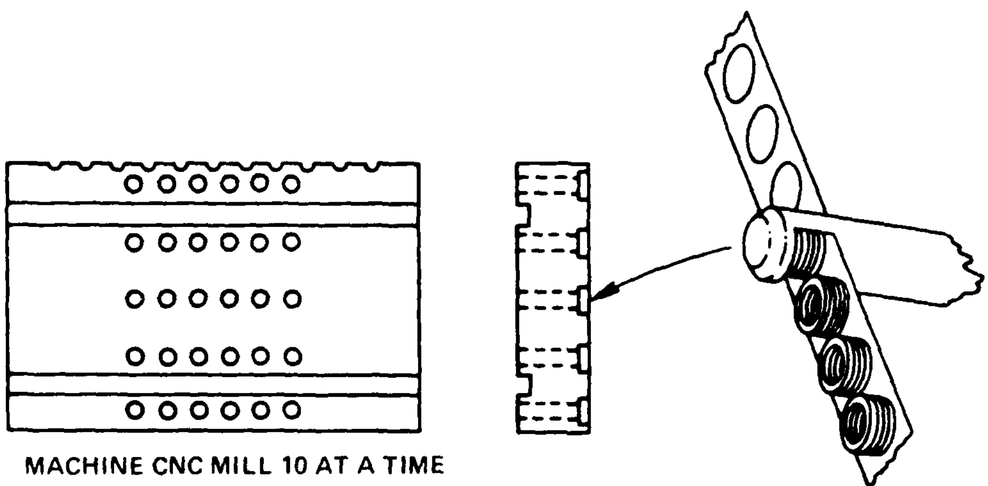
Tuner/Motor Plates - Currently, the top, center and base plates are milled one plate at a time. Engineering looked at the possibility of machining the top and center plates from extruded material, (Figure 43) but was dropped in favor of the less expensive technique of using a CNC controlled machine which permits up to ten plates of each kind to be milled at a time. (See Figures 44 and 45.)

End Cap - Tuner Rod Cap - Tuner Port - These three parts currently are individually machined which requires individual set ups and machining. With the MT method, the parts will be made on CNC controlled machines at a reduced part cost. (See Figure 46.)



MACHINE – MILL 1 AT A TIME
HAND INSERTION OF HELICOILS

PRESENT METHOD



MACHINE CNC MILL 10 AT A TIME
STRIP FED INSERTION

MT METHOD (A)

FIGURE 41. TUNER CAM PLATE

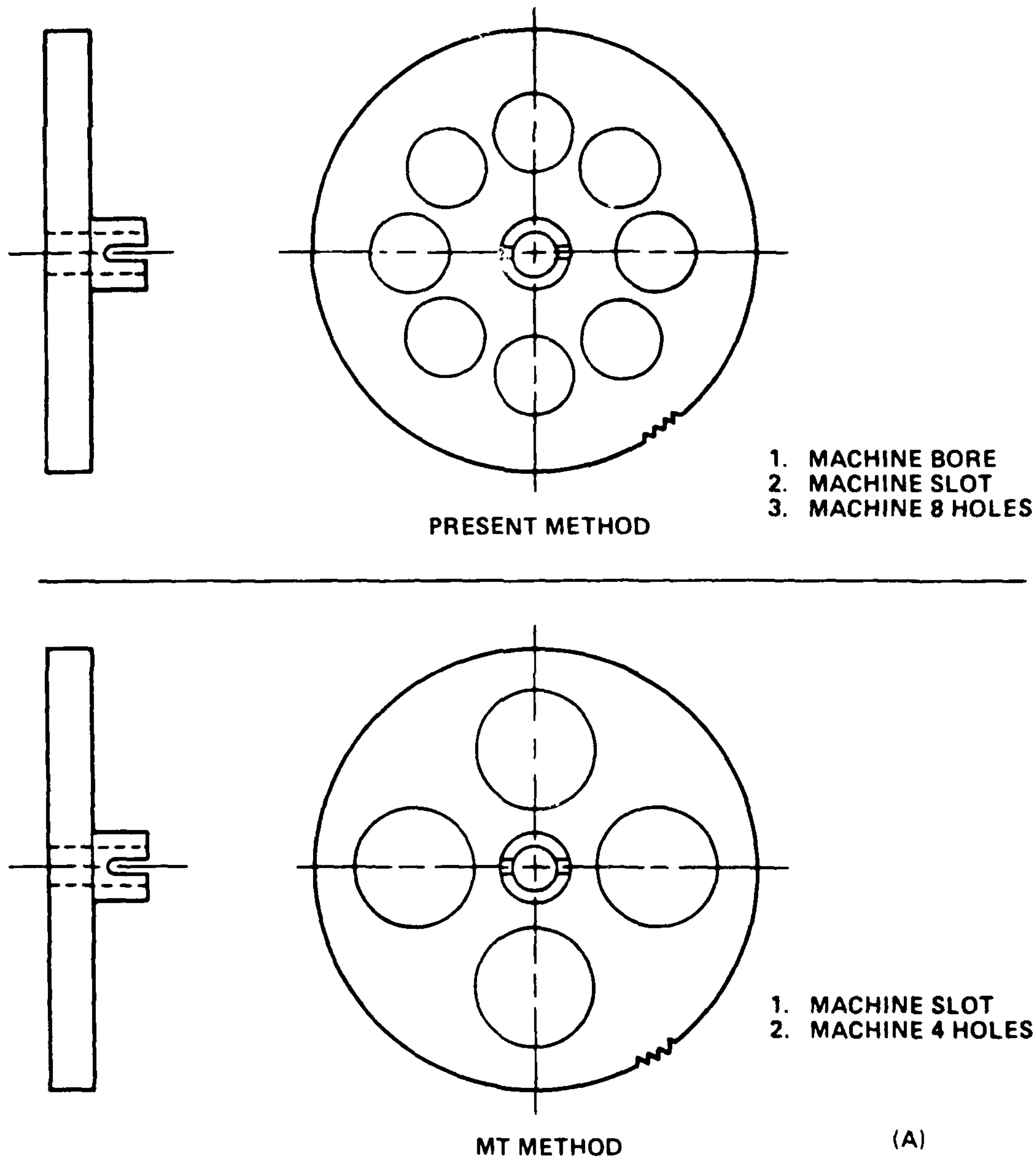


FIGURE 42. LOCK/UNLOCK GEAR

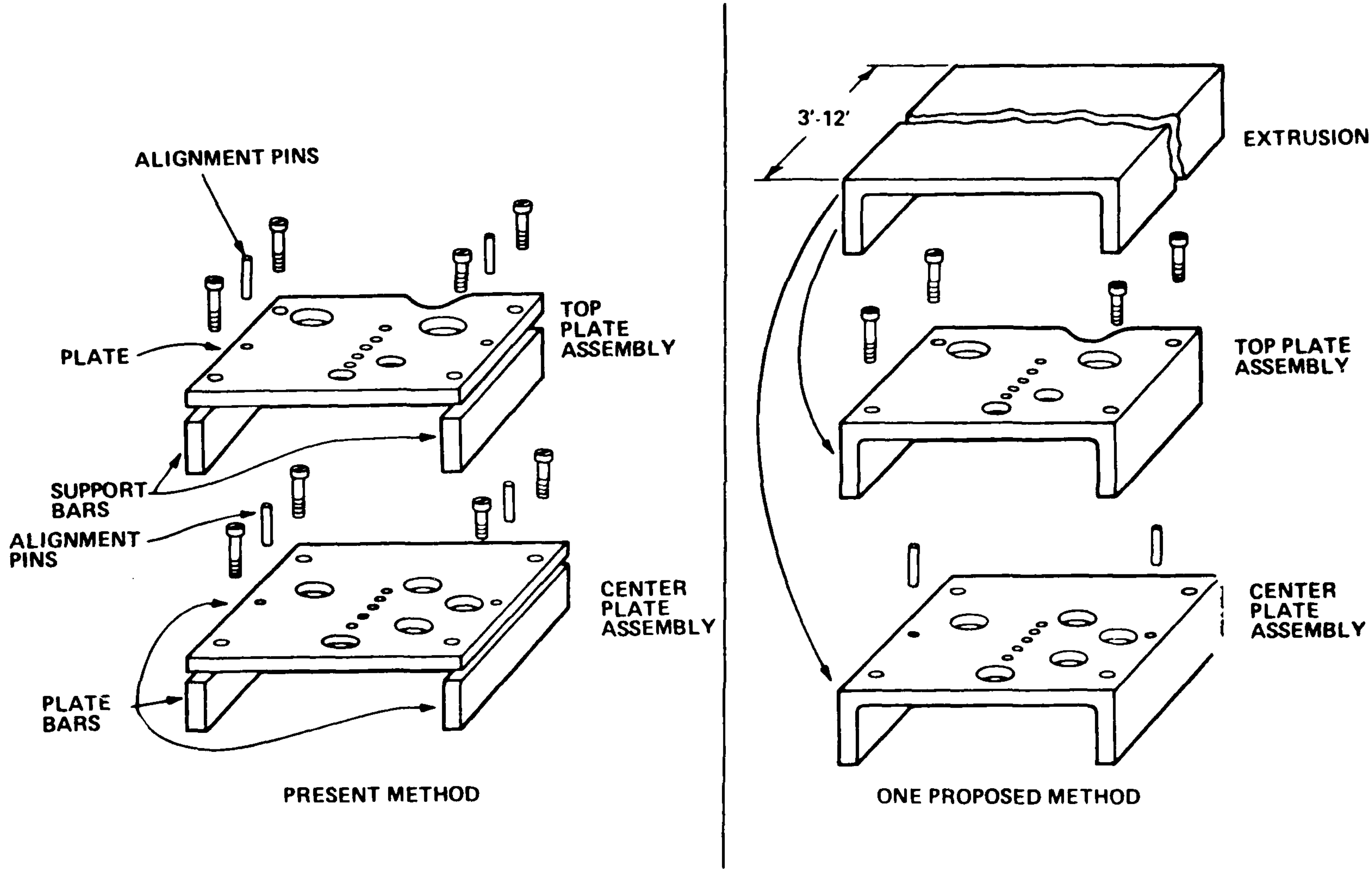


FIGURE 43. TOP AND CENTER MOTOR DRIVE PLATES

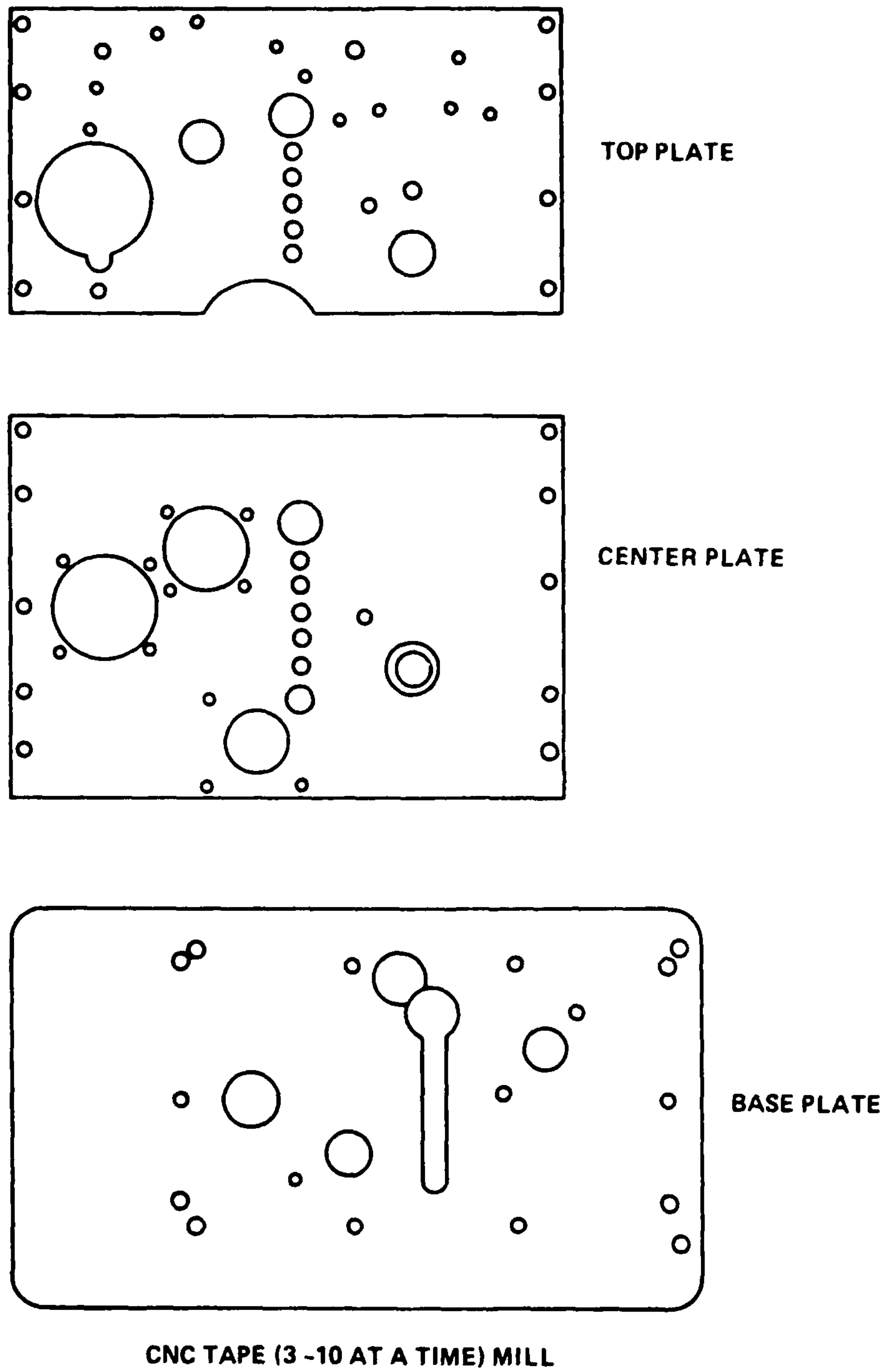


FIGURE 44. MOTOR DRIVE PLATES

FOLLOWING PARTS – NO CHANGE IN DIMENSIONS
– BUT MADE WITH DIFFERENT METHOD, MATERIAL, TOOLING OR FIXTURING.

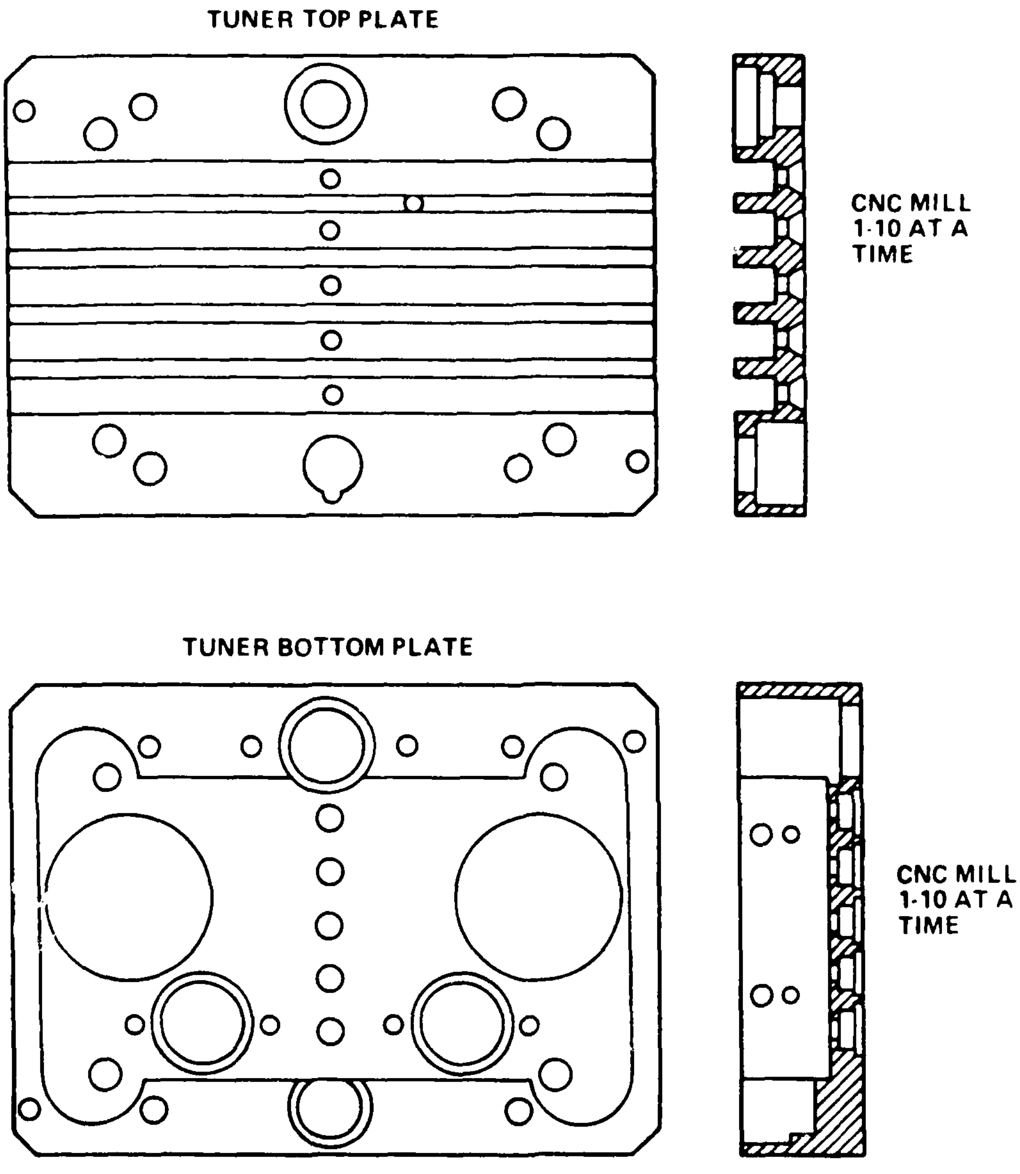


FIGURE 45. TUNER PLATES

FOLLOWING PARTS – NO CHANGE IN DIMENSIONS
– BUT MADE WITH DIFFERENT METHOD, MATERIAL, TOOLING OR FIXTURING.

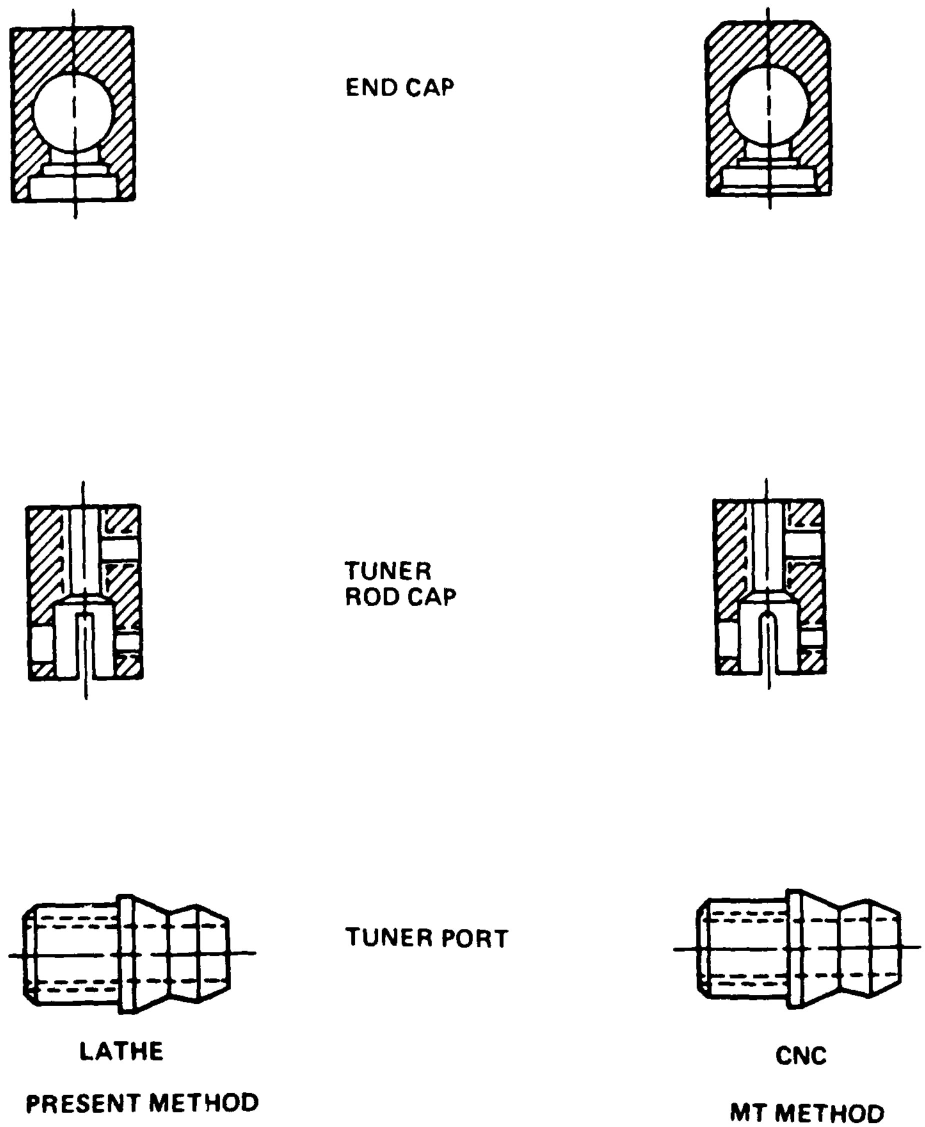


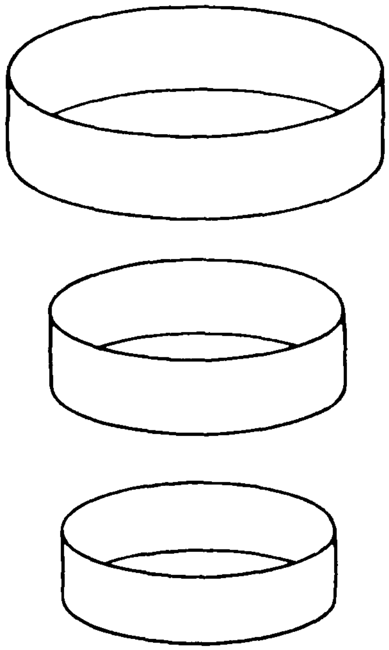
FIGURE 46. END CAP, TUNER ROD CAP, TUNER PORT

Collector Cup - Outer Heliarc Ring - Inner Heliarc Ring - Varian currently manufactures these three parts using the hydroform method then machines the parts to their final size. The new technique will be to blank, pierce, form and trim. This method produces a reduced part cost. (See Figure 47 A.)

Water Channel Plate - The present technique is to receive a machined blank, then the water channels are milled. Two channel plates are required per tube. The MT method will require the parts to be made by a CNC controlled machine with up to ten channel plates being fabricated simultaneously. (See Figure 47 B.)

Collector Cap - Varian is presently individually machining the collector caps on a lathe. The new technique will be to use CNC controlled machines. (See Figure 47 C.)

FOLLOWING PARTS – NO CHANGE IN DIMENSIONS
– BUT MADE WITH DIFFERENT METHOD
TOOLING OR FIXTURING



COLLECTOR CUP (2)

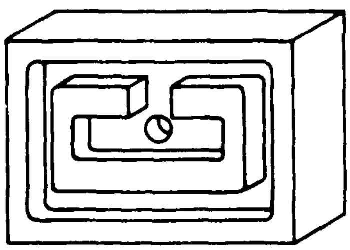
OUTER HELIARC RING

INNER HELIARC RING

PRESENT METHOD
BLANK
HYDROFORM
MACHINE

MT METHOD
BLANK AND PIERCE
FORM AND TRIM

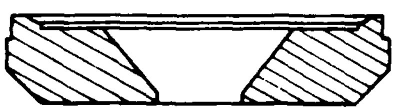
(A)



PRESENT METHOD
MACHINE INDIVIDUAL BLANK TO SIZE – MACHINE WATER CHANNELS BOTH SIDES
WATER CHANNEL

(B)

MT METHOD
USING CNC MACHINE AND FIXTURE – 10 PIECES FROM ONE BAR – MACHINE BAR TO WIDTH AND THICKNESS ONE SIDE – CHANNELS COMPLETED – OPPOSITE SURFACE MACHINED TO THICKNESS AND COUNTERBORED – PART OFF FINAL PARTS TO LENGTH.



COLLECTOR CAP

(C)

PRESENT METHOD
LATHE

MT METHOD
CNC LATHE

FIGURE 47. COLLECTOR CUP, OUTER AND INNER HELIARC RING, WATER CHANNEL AND COLLECTOR CAP

28. CATHODE COOLING FIN SPACERS

To reduce cathode cooling fin spacer cost, Engineering reviewed the process of mounting the cooling fin to the cathode polepiece.

PRESENT METHOD - VKU-7785F

Initially the four mylar posts were purchased to the approximate length required to mount the cooling fin to the cathode polepiece. Each tube required the technician to individually measure the distance between the cooling fin and the polepiece due to variations in the potting height. The standoffs were then taken to the machine shop to be faced off to the individual standoff required lengths. (See Figure 48.)

MT METHOD - VKU-7785F

Varian purchases the mylar material in random lengths of two to four foot lengths. The distance required to mount the cooling fin to the cathode polepiece is still measured as before, then the mylar is cut to the measured distance, drilled and tapped in one setup. This results in a material and labor savings. (See Figure 48 A.)

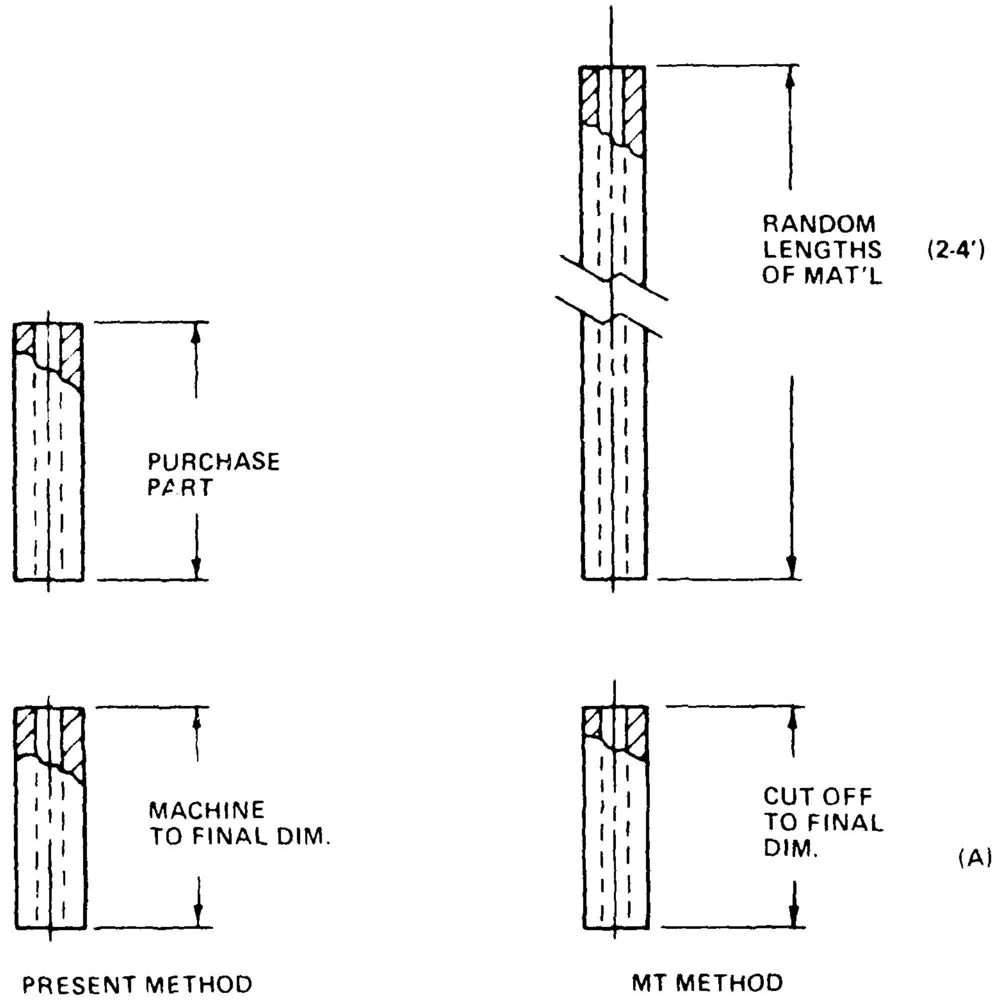
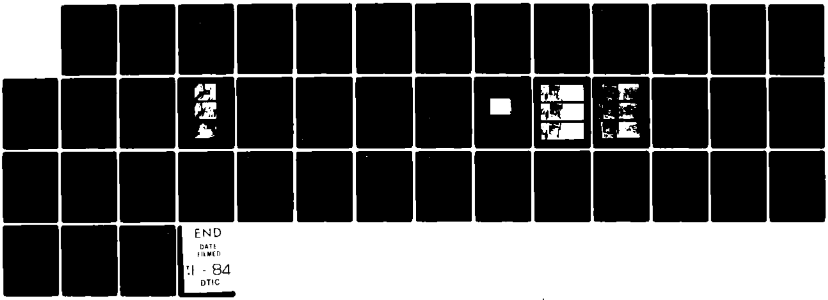
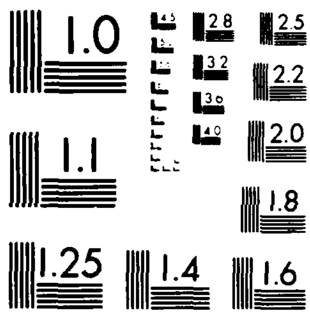


FIGURE 48. CATHODE COOLING FIN SPACER

AD-A135 782 KLYSTRON MANUFACTURING TECHNOLOGY PROGRAM(U) VARIAN ASSOCIATES INC PALO ALTO CA PALO ALTO MICROWAVE TUBE DIV SEP 83 NOSC-CR-198 N00123-81-C-0245 2/2

UNCLASSIFIED F/G 13/8 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

29. POWDER METALLURGY PARTS

Engineering, in their evaluation of ways to reduce machining times and in keeping with the intent of an MT program, has investigated the use of powder metallurgy parts.

Engineering selected three parts as potential candidates for use on this new processing technique. They are tuner bridge (used internal to the vacuum), tuner adaptor channel plate assembly and water fitting (used external to vacuum).

Tube manufacturers have historically stayed away from sintered material inside the vacuum envelope due to the outgassing characteristics associated with sintered material.

The process of powder metallurgy involves mixing the polystyrene plastic with powders needed to make a specific alloy (i.e., Monel 404 requires 52-57% pure nickel and the remainder copper) pelletizing and feeding the feed stock into a standard plastic injection molding machine. The metal powder in this process ranges from 0.8 micron to 8.0 micron in size versus a 10-40 micron particle size used in normal powder metallurgy practice. (See Figure 49.)

Attempts to use PM parts in this application have resulted in erratic results due to leaching, erratic plating quality, non-uniform braze flow, minor element contamination, long-term outgassing problems, mechanical failure, and relatively high initial tooling costs.

Varian has not introduced powder metallurgy parts into the VKU-7785F MT klystron.

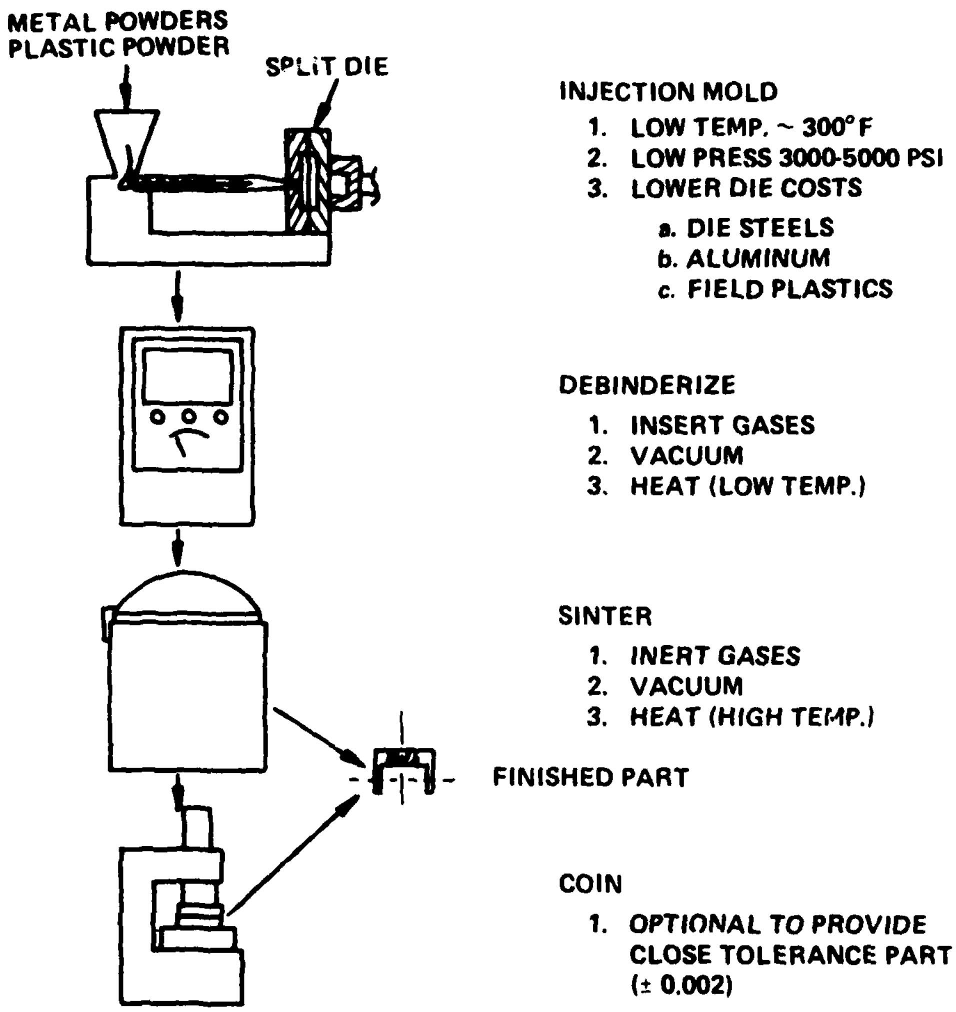


FIGURE 49. POWER METALLURGY PROCESS

30. MT PROGRAM SUMMARY

Table 2 shows the summary of reductions on the MT program. The number of piece parts, braze and machining operations has been reduced and as a result, the number of labor hours required to manufacture the klystron amplifier has decreased.

The process and methods changes and parts reductions described in this report, if fully implemented, would lead to an overall reduction of over 10% from the pre-MT Program cost for the VKU-7785 power klystron and autotuner. Similar incremental savings can also be realized when these proven technologies are applied to other high power klystrons.

TABLE 2

VKU-7785F MT PROGRAM

SUMMARY OF REDUCTIONS

FIRST BODY ASSEMBLY THROUGH SEAL-IN ASSEMBLY

	VKU-7785E	VKU-7785F
Piece Parts	85	67
Braze Rings and Wafers	84	65
Braze Operations	29	12
Brazed Assembly	31	18
Machining Operations	5	3
Cavity Testing Operation	4	2

FIRST AND SECOND DRESS ASSEMBLY

(Reductions)	
Piece Parts	10
Assemblies	5
Solder Operations	3
Potting Operation	2
Assembly Operation	1

(Added one braze operation)

SECTION 31

QUALIFICATION PROGRAM

MINI QUALIFICATION TESTS
ON MT POWER KLYSTRON AND AUTOTUNER ASSEMBLY
VKU-7785F

PERIODIC CONFORMANCE INSPECTION

* ACCEPTANCE TEST DATA REPORT (VARIAN)
* RANDOM VIBRATION, AND OPERATING SHOCK TEST REPORT (DALMO VICTOR)
* POST VIBRATION TEST REPORT (VARIAN)
* POST SHOCK TEST REPORT (VARIAN)
* TEMPERATURE CYCLING (VARIAN)

AND

POST TEMPERATURE CYCLING TEST REPORT

CONDUCTED AT VARIAN MICROWAVE TUBE DIVISION
PALO ALTO, CALIFORNIA
AND
DALMO VICTOR TEST LAB
BELMONT, CALIFORNIA
AUGUST 23, 1982

QUALIFICATION PROGRAM

In order to assure the Government, Naval Ocean System Command, the Weapon System manufacturer, General Dynamics, Pomona, and Varian, the MT contractor that the new methodology, technologies and process changes introduced into the MT power klystron and autotuner assembly - VKU-7785F, do not have an adverse effect on the operation of the tube or its final system performance, Varian conducted a mini-qualification test on one of the three MT tubes. This tube was randomly selected by the Government and was environmentally tested for temperature cycling, random vibration and operating shock. These tests were conducted at Dalmo Victor Test Labs in Belmont, California and Varian.

Each of the three MT power klystrons and autotuner assemblies were run to the full Acceptance Test Procedure (ATP) Instruction 5.288, OD53977 dated 24 July 1979 prior to the Government's random selection of one tube S/N B which was tested to the agreed environmental tests conducted on the present production tubes periodically throughout the manufacturing of VKU-7785E tubes. This periodic environmental test is called Periodic Conformance Inspection (PCI). It consists of a full acceptance test of the tube performance parameters prior to the environmental test, temperature cycle, post temperature acceptance tests, random vibration, post random vibration test, operating shock, and post shock acceptance tests.

Varian feels that requalification of the "F" Series klystron is not required as all changes are considered class II type changes. The changes made in the MT Program are not considered design type changes, but are in line with normal productization of the existing design. These changes do not affect form, fit, or function.

Results of PCI tests are included in a separate report and the summary is included in this final report.

APPENDIX A

ACCEPTANCE TEST DATA

QUALITY CONFORMANCE INSPECTION

ACCEPTANCE TEST DATA SHEETS

KLYSTRON AMPLIFIER

VKU-7785F

SERIAL NO. B

NAVSEA P/N 5186595

NAVSEA WS 18608

VARIAN DRAWING R092650

varian

QUALITY CONFORMANCE INSPECTION, PART I

KLYSTRON AMPLIFIER

VKU-7785[illegible] SERIAL NO. [illegible]

100% ACCEPTANCE TESTS

ATP NO. 5.193

TEST	TEST CONDITION		SPECIFICATION MIN	SPECIFICATION MAX	TUBE PERFORMANCE		
HEATER CURRENT (Ref Para 4.1)	Ef = 9.0 Vrms	If:	...	8.0	If=	7.40	A
PEAK CATHODE CURRENT (Ref Para 4.2)	Pulse Test Condition, A Drive Power = 0	Ik:	...	4.0	Ik=	3.45	A
WARM UP (Ref Para 4.19)	Pulse Test Condition, A (Channel 4)	t:	...	5.0	t=	5.0	min
BODY CURRENT & POWER OUTPUT PULSED (Ref Para 4.4 & 4.23)	Pulse Test Condition, A	Po:	25.5	...	Po=	27.4	kW
		iby:	...	850	iby=	312	ma
Test Conditions verified (✓)							

TEST	CHANNEL NO.	PARAMETER	SPECIFICATION MIN	SPECIFICATION MAX	SELECT SET NUMBER 1ST CYCLE			SELECT SET NUMBER 17TH CYCLE		
RF FREQUENCY, BANDWIDTH and CHANNEL SELECT TIME (Ref Para 4.4, 4.5, 4.7, 4.11)	1	Frequency	fo−501MHz	fo−499MHz	fo−	500	MHz	fo−	500	MHz
		Po	25.5 KW	.....		33.4	KW		33.4	KW
		BW (−3dB)	25 MHz	45 MHz		27	MHz		27	MHz
	2	Frequency	fo−326MHz	fo−324MHz	fo−	325	MHz	fo−	325	MHz
		Po	25.5 KW	.....		33.4	KW		33.0	KW
		BW (−3dB)	25 MHz	45 MHz		27	MHz		28	MHz
	3	Frequency	fo−151MHz	fo−149MHz	fo−	150	MHz	fo−	150	MHz
		Po	25.5 KW	.....		33.0	KW		32.0	KW
		BW (−3dB)	25 MHz	45 MHz		28	MHz		28	MHz
	4	Frequency	fo−1 MHz	fo± MHz	fo+	0	MHz	fo+	0	MHz
		Po	25.5 KW	.....		32.5	KW		32.0	KW
		BW (−3dB)	25 MHz	45 MHz		29	MHz		28	MHz
	5	Frequency	fo+249MHz	fo+251MHz	fo+	250	MHz	fo+	250	MHz
		Po	25.5 KW	.....		31.6	KW		31.4	KW
		BW (−3dB)	25 MHz	45 MHz		30	MHz		29	MHz
	6	Frequency	fo+499MHz	fo+501MHz	fo+	500	MHz	fo+	500	MHz
		Po	25.5 KW	.....		30.6	KW		28.6	KW
		BW (−3dB)	25 MHz	45 MHz		32	MHz		32	MHz

Each channel select during the first and seventeenth selection set, was accomplished in a maximum of 20 seconds. Verified (✓)

ATP NO. 5.193

TEST	TEST CONDITION		SPECIFICATION MIN	MAX	TUBE PERFORMANCE		
LEAKAGE CURRENT (Ref Para 4.8)	Ef = 9.0 Vrms Eb = −26 kVdc Ec = −29.4 kVdc	Llc	...	3	Llc=	.1	mA
PULSE DUTY FACTOR, RF (Ref Para 4 12)	Pulse Test Cond. A	Pulse Du	.03528	.03672	Du=	.036	
BEAM DUTY FACTOR (Ref Para 4 12)	Pulse Test Cond. B	Beam Du	.05390	.05610	Du=	.055	
DIMENSIONS (Ref Para 4 10)	Per Outline Dwg No 143754 In Compliance with NAVSEA Dwg. No. 5186595 and M8 13		...	...	Date		
PRESSURE DROP (Ref Para 4.20)	Coll. Water Flow=4 GPM	Press.	...	25	Press.	9.5	psi
	Body Water Flow=1 GPM @ Water Temp=20 ± 10°C	Press.	...	25	Press.	8.0	psi
WAVEGUIDE AIR PRESSURE (Ref Para 4.18)	t=0	Press.	...	20	Press.	20.0	psig
	t=10 minutes	Press.	19	...	Press	20.0	psig
STATIC PRESSURE (Ref Para 4.21)	Collector	psi	150	...	No Leaks	OK	
	Body	psi	150	...	No Leaks	OK	
DIELECTRIC WITHSTANDING VOLTAGE (Ref Para 4.17)	(a) Motor, Clutch and Switch Leads	VRMS	600	...	VRMS=	600	
	(b) Hi-Pot, Fil, Cath, Grid to Ground	kV	42	...	kV=	42.0	
	(c) Grid Bias Voltage	kV	−3.8	...	kV=	-4.0	

varian

QUALITY CONFORMANCE INSPECTION, PART I

KLYSTRON AMPLIFIER

VKU-7785 SERIAL NO.

100% ACCEPTANCE TESTS (Continued)

ATP NO. 5.193

TEST	TEST CONDITION		SPECIFICATION MIN	MAX	TUBE PERFORMANCE	
CAPACITANCE (Ref Para 4.13)	Control Electrode to All Other Electrodes	Cg	...	100	Cg= 63.8	pf
WEIGHT IDENTIFICATION MARKING & WORKMANSHIP (Ref Para 4.10)			...	80		lbs
TUNING CAPABILITY (Ref Para 4.11)	Pulse Test Cond. A Channel Changes		102	...	102	
INSULATION RESISTANCE (Ref Para 4.16)	500 Vdc Between Isolated Circuits	Resistance	25	...	221	MΩ
DYNAMIC BURN-IN (Ref Para 4.22)	Heater Elapsed Time		40	-	65	Hrs.
	Grid Bias Elapsed Time		40	-	53	Hrs.
	Beam Voltage Elapsed Time		40	-	53.8	Hrs.
	Pulse Cond. Per Spec.		-	-	N/A	Hrs
	Supplemental Elapsed Time		-	-	N/A	Hrs

Tested By [signature] Date 8-5-82

Approved By [signature] Date 8 20 82

Witnessed By Claus Schumacher Date 8-20-82

APPENDIX B

VKU-7785F S/N B

VIBRATION SHOCK TEST REPORT

AND PHOTOGRAPHS

DALMO VICTOR
Division of Textron, Inc.

1515 Industrial Way Belmont, California 94002

Phone: 591-1414

ENVIRONMENTAL TEST LABORATORY

FLASH REPORT

Date	TR No.	Project	Account No.	Task No.	Test Engineer
26Aug82	4168	Varian	L 360	504	Pershing

Part Number	Serial Number	Environment
VKU 7765	B	Vibration and shock

Specimen	Start Date	Completion Date
Klystron	23Aug82	25Aug82

Test Authorization and Specification	Approval	Date
Varian direction	P. Pershing	26Aug82

Test Objectives: To verify the ability of the Klystron to operate after being subjected to a shock and vibration environment.

Test Procedures: Varian direction.

Test Results: The Klystron was subjected to the required environments. All performance data was retained by Varian.

Remarks:

B2

28 024 (7/70)

Page___of___

TEST ORDER	This Space for Test Lab Approval
Date 18 AUG 82	Test Request No 4168
Test Title SHOCK & VIB	Estimated Start Date
Test Specimen VARIAW	Estimated Completion Date
Size ____ Weight ____	Estimated Tooling Cost
Start Date Desired 23 AUG 82	Est Tooling Compl Date
Completion Date Desired	
Account No 6-360 Task No 504	Estimated Cost
Requestor R. Phillips Ext	Envir Engineer
Authorized by ____ Ext	Approved by

Report Desired	Type of Test	Surveillance Required	Disposition
○ Raw Data ○ Photographs	○ Qual ○ Design Proof	○ Government	○ Return Specimen
○ Brief Summary ○ Detailed Report	○ R & D ○ Other	○ Other	○ Scrap Specimen

Specific Detail of Test, Including Test Procedures, Fixtures Required, Etc (Attach additional pages as required)	Instrumentation Required
Big Beast see TR- 4027	

Specification and/or References	Distribution
	Requestor (1) Environmental Lab (2) (3) Total

B3

TEST SPECIMEN VARIAN P/N VKU 7785 SERIAL NUMBER B

TEST PROCEDURE ______ ISSUE ______ PROJECT NUMBER ______

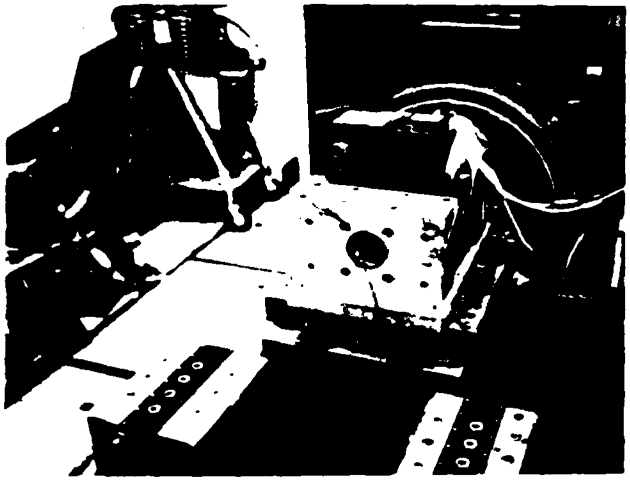
TEST TITLE ______ TR NUMBER 4168 DATE 23 AUG 82

ACCOUNT NUMBER C-360 PROJECT ______ ENVIRONMENT VIB & SHOCK

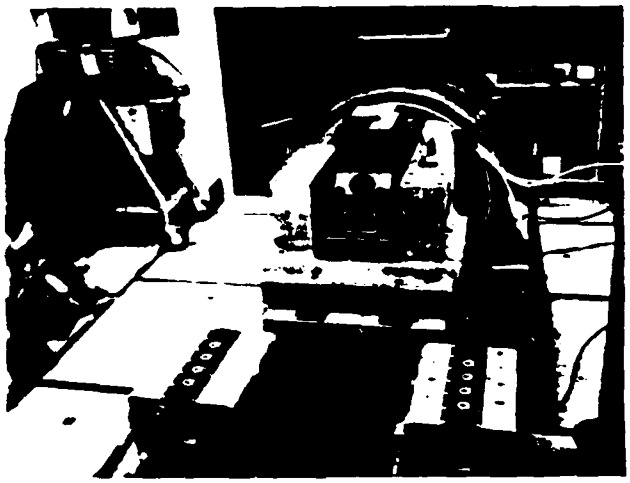
PARA	START	END	COMMENTS	INITIALS	DATE
	0830		Set in Program -	TP	23 Aug 82
	1030		Unit Arrive		
			Mount in Y Axis	TP	23 Aug 82
	1145		Start Run 30 min		
	0745		Unit Returns	TP	24 Aug 82
			Mount in Z Axis		
	0820		Start Run - 30 min		
		0850	End Run -		
			Mount in X Axis		
	1400		Start Run - 30 min		
	1215		Shock 30 g 11 m sec ½ sine	TP	25 Aug 82
			+ Vert 1 Drop		
			- Vert 1		
			- Long 1		
			+ Long 1		
			+ Lat Axis 1		
	1245		- Lat Axis		
			B4		

Page 01

07.011



Y Axis



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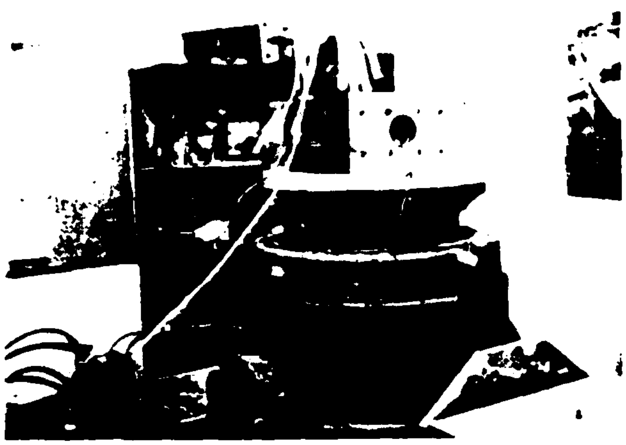
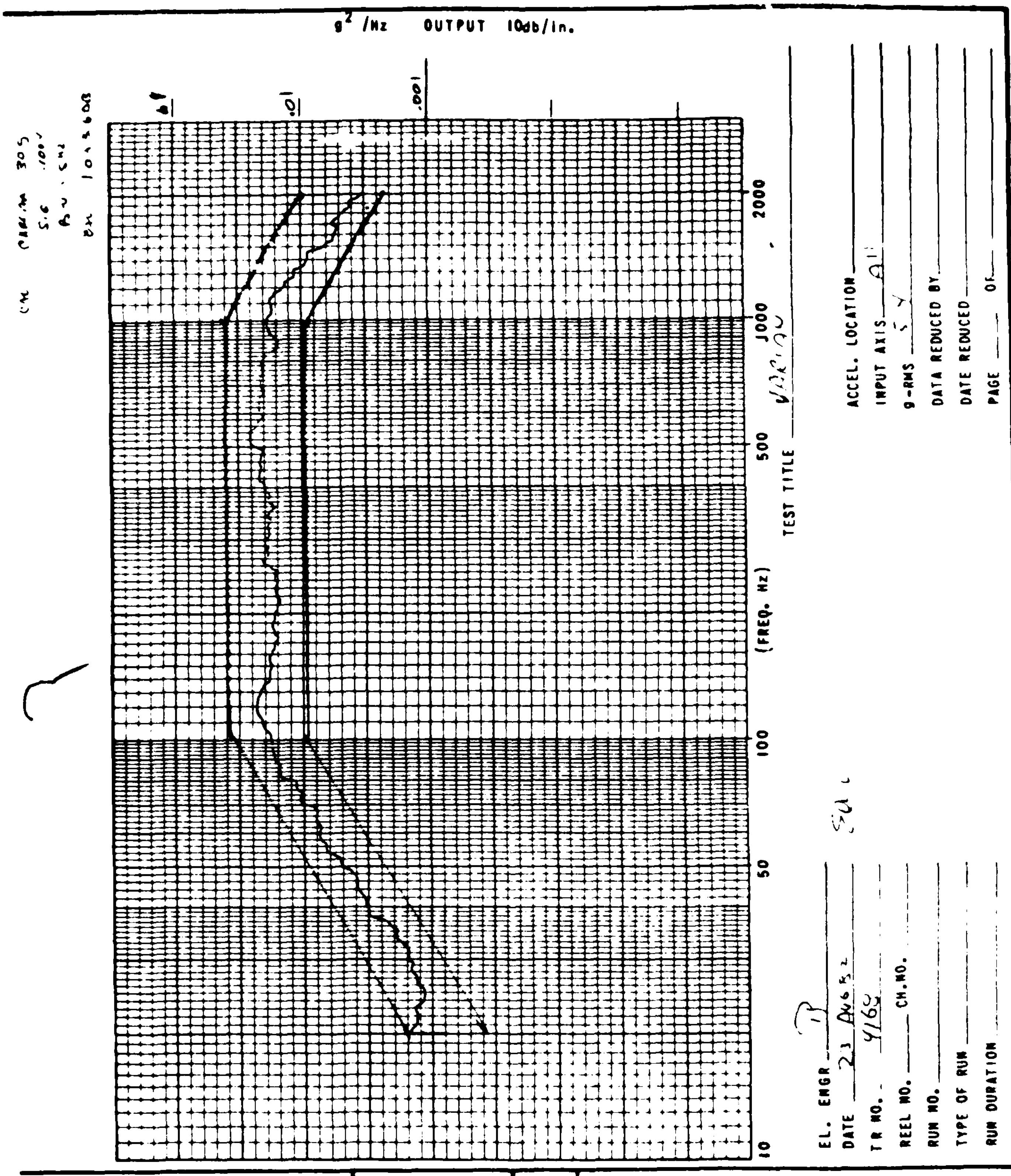


X Axis



DALMO VICTOR COMPANY

BELMONT CALIFORNIA A DIVISION

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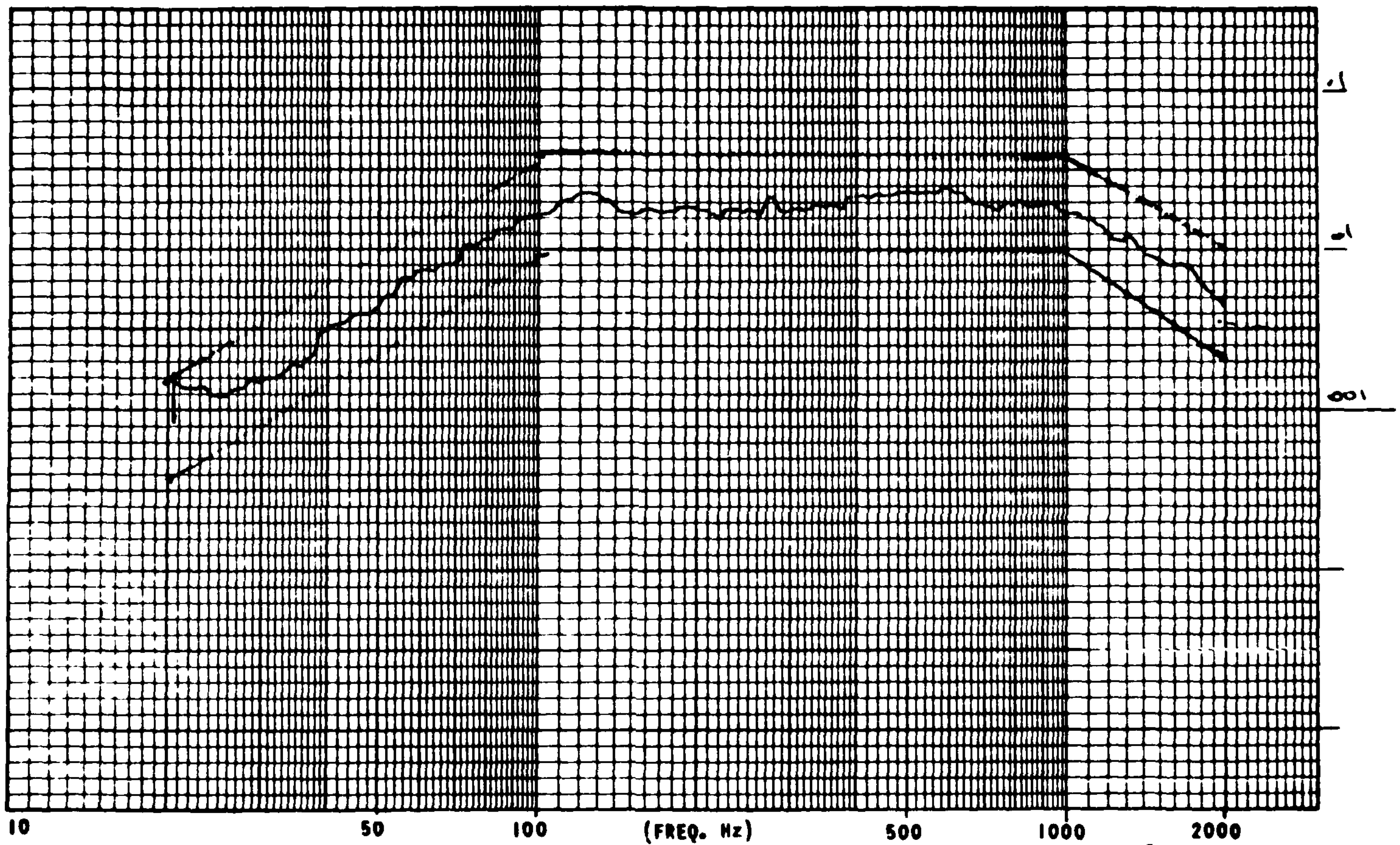

TEST TITLE Uniaxial

EL. ENGR 11

DATE 23 AUG 82

T R NO. 4168

REEL NO. ____ CH.NO. ____

RUN NO. ____

TYPE OF RUN Fr

RUN DURATION 30 min

P/N VKU 7785

S/N B

ACCEL. LOCATION on fix

INPUT AXIS Y

g-RMS 5.1

DATA REDUCED BY ____

DATE REDUCED ____

PAGE ____ OF ____

DALMO VICTOR COMPANY

BELMONT CALIFORNIA A [redacted] DIVISION

CODE IDENT NO.	SIZE
15786	A

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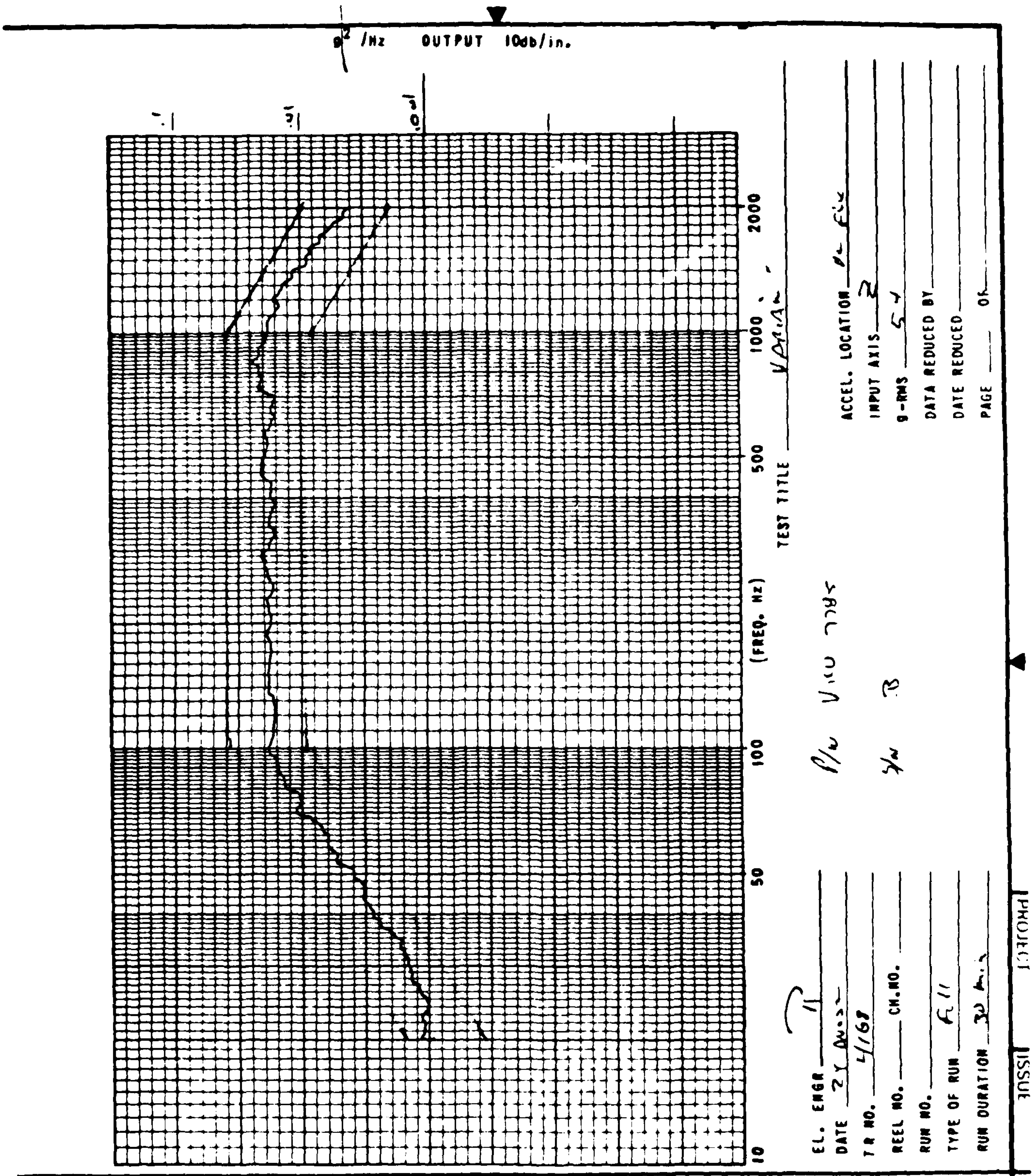

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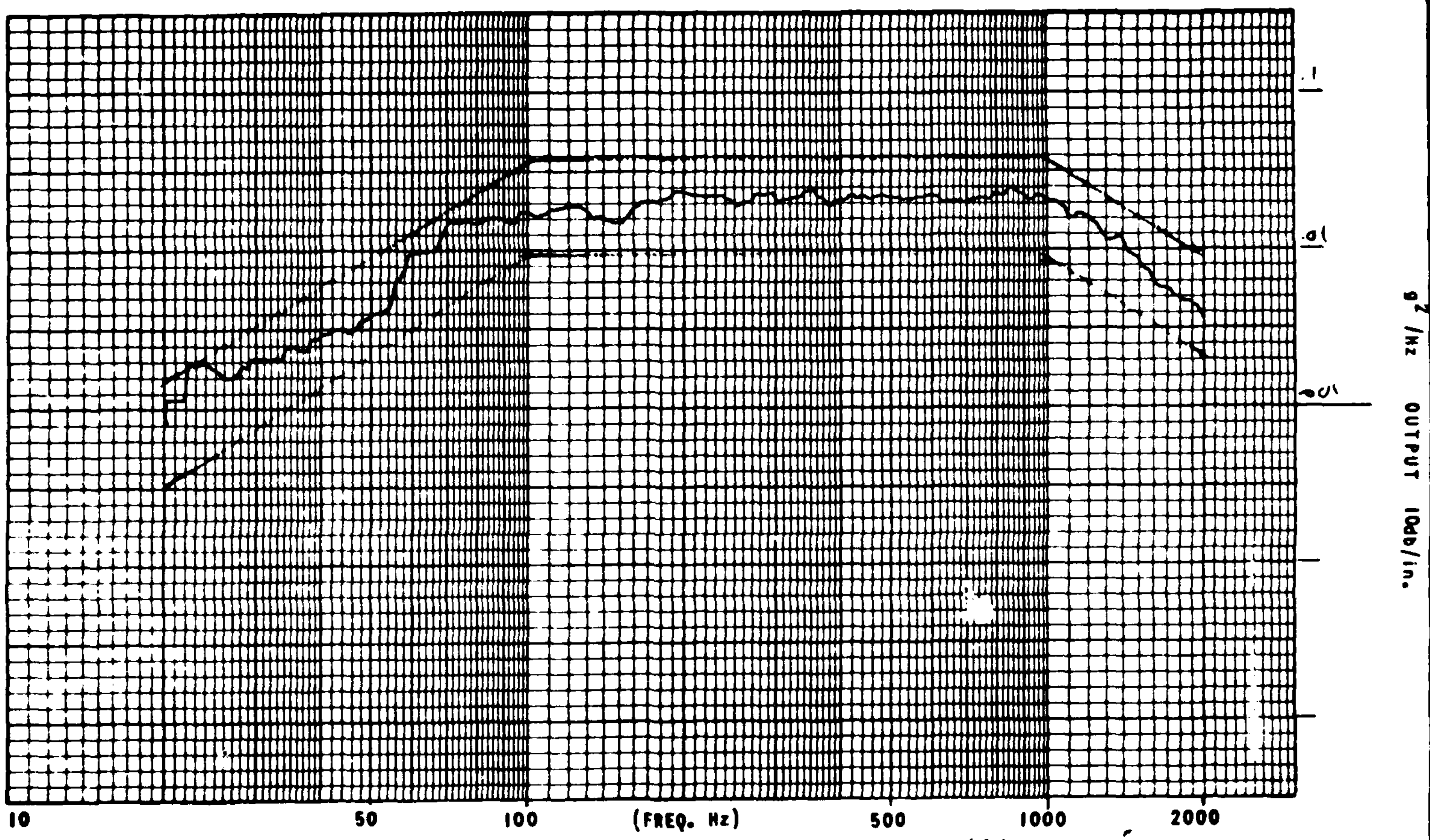
		B8	SHEET OF



TEST TITLE

EL. ENGR

DATE 23 AUG 82

T R NO. 4168

REEL NO. ___ CH. NO.

RUN NO.

TYPE OF RUN

RUN DURATION

ACCEL. LOCATION

INPUT AXIS

g-RMS

DATA REDUCED BY

DATE REDUCED

PAGE ___ OF

ISSUE

DALMO VICTOR COMPANY

BELMONT CALIFORNIA [redacted] DIVISION

CODE IDENT NO 15786

SIZE A

B9

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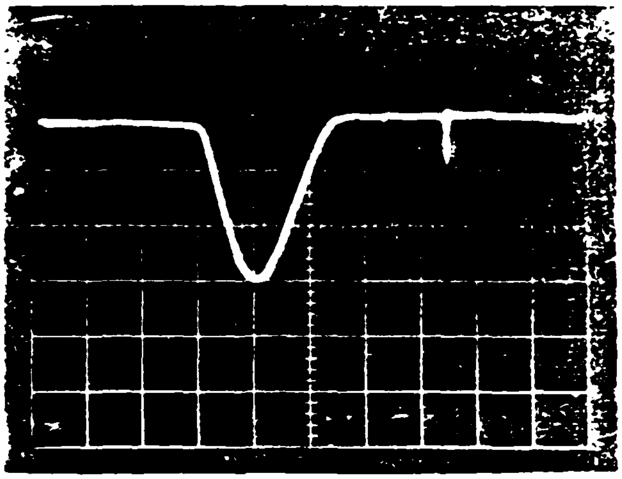

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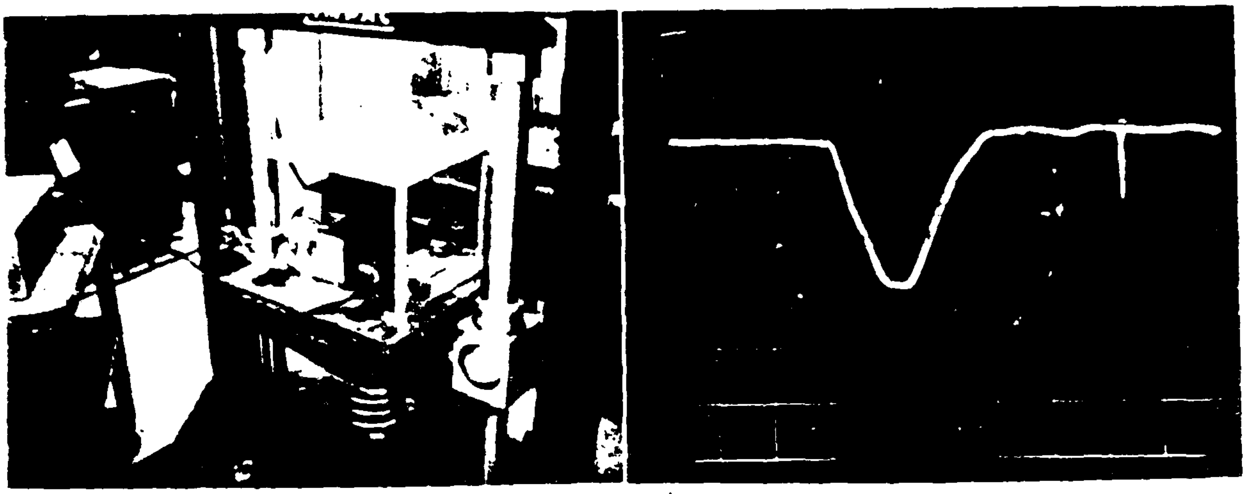

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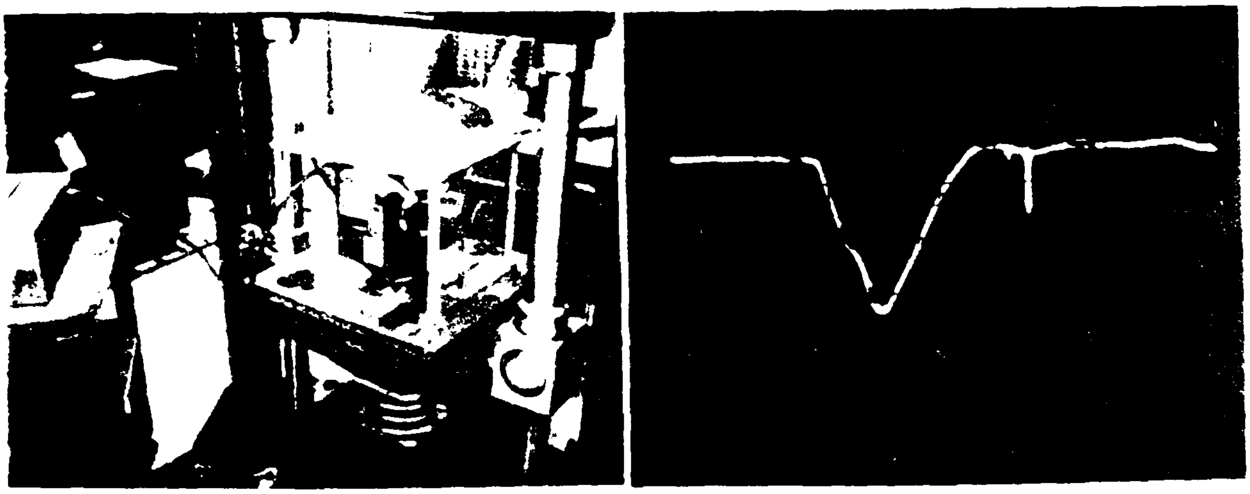

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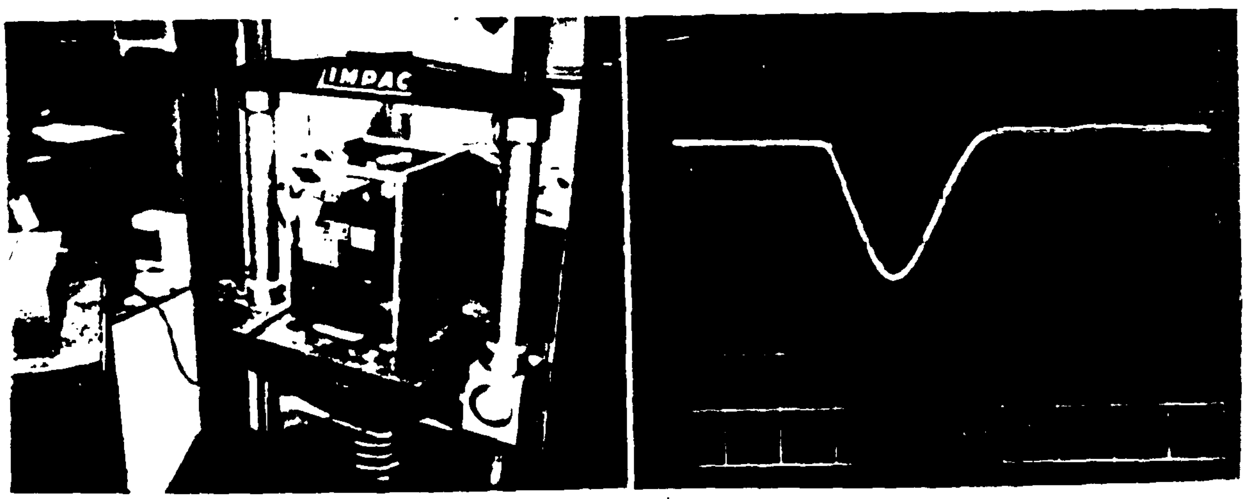

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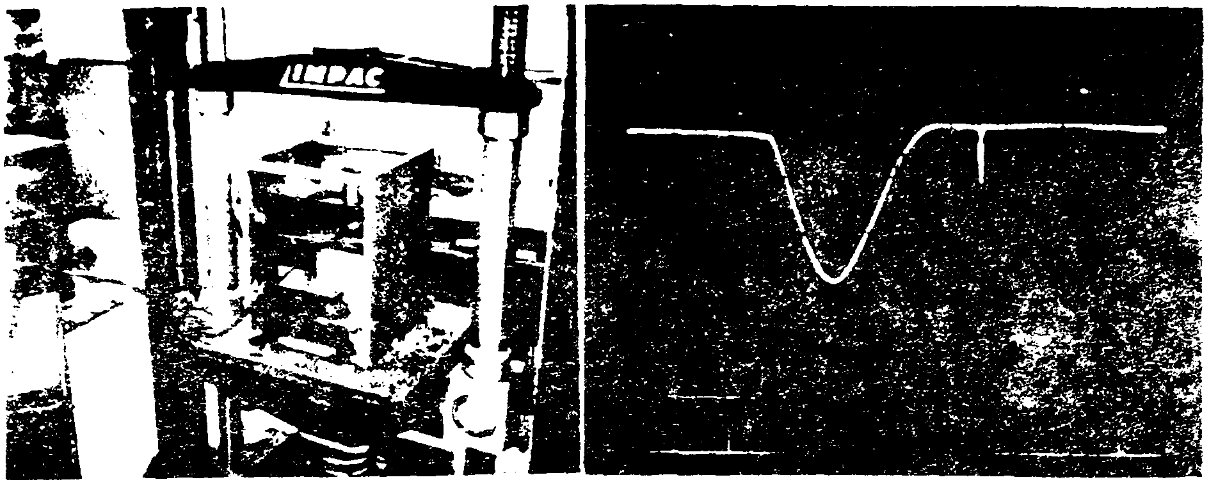

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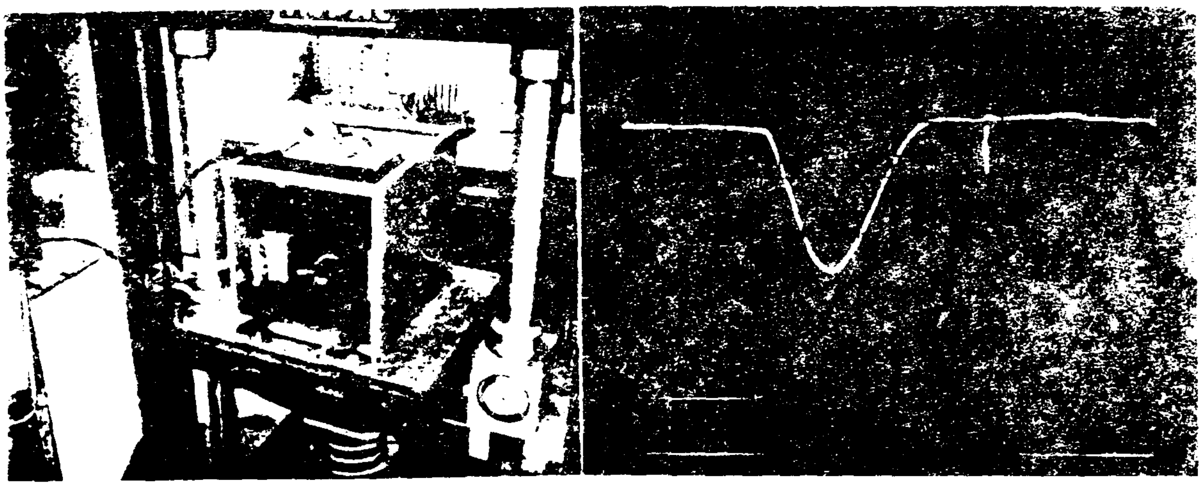
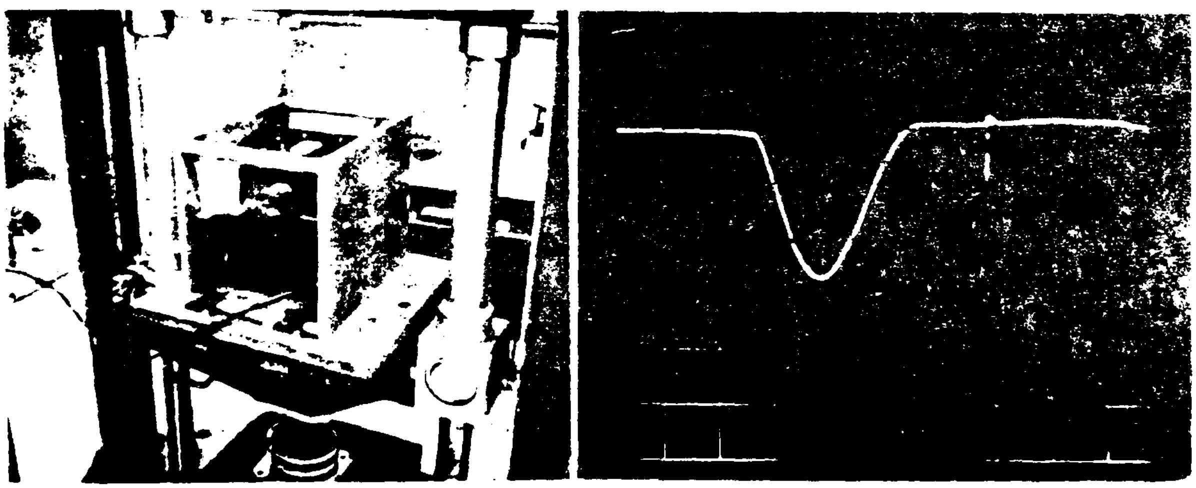


+ Latitude



- Latitude

APPENDIX C

VKU-7785F S/N B

POST VIBRATION TESTS

Section 6.0 Random Vibration (Section 5.2)

TEST	TEST CONDITION		SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE 1	TUBE PERFORMANCE 2
RF Frequency & Bandwidth & Channel Select Time (Ref Para 4.5 & 4.7)	(CHANNEL 1) Frequency = Fo -500 MHz	Po:	25.5	---	Po= 31.1	31.6 kW
		-3dB BW:	20	45	BW= 27	29 MHz
	(CHANNEL 2) Frequency = Fo -325 MHz	Po:	25.5	---	Po= 30.6	31.4 kW
		-3dB BW:	20	45	BW= 27	29 MHz
	(CHANNEL 3) Frequency = Fo -150 MHz	Po:	25.5	---	Po= 30.0	31.1 kW
		-3dB BW:	20	45	BW= 28	30 MHz
	(CHANNEL 4) Frequency = Fo	Po:	25.5	---	Po= 27.5	30.8 kW
		-3dB BW:	20	45	BW= 27	31 MHz
	(CHANNEL 5) Frequency = Fo +250 MHz	Po:	25.5	---	Po= 27.8	24.2 kW
		-3dB BW:	20	45	BW= 31	33 MHz
	(CHANNEL 6) Frequency = Fo +500 MHz	Po:	25.5	---	Po= 25.8	26.1 kW
		-3dB BW:	20	45	BW= 32	34 MHz

	Plane 1 Start	Plane 1 Finish	Plane 2 Start	Plane 2 Finish	Plane 3 Start	Plane 3 Finish
Beam voltage (kV)	26	26	26	26	26	26
Grid voltage (kV)	4	4	4	4	4	4

Section 6.0 Post Random Vibration Tests: (Section 5.2)

TEST	TEST CONDITION		SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE
Static Pressure (Ref Para 4.21)	Collector	psi:	150	---	No Leaks ok
	Body	psi:	150	---	No Leaks ok
Body Current & Power Output Pulsed (Ref Para 4.4 & 4.23)	Pulse Test Condition, A	Po:	25.5	---	Po= 27.2 kW
		Iby:	---	850	Iby= 300 ma
	Test Condition Verified	(✓)			
Output Load (Ref Para 4.9)	Pulse Test Condition, A				
	(CHANNEL 1)				
	1.1:1 Load	Po:	25.5	---	Po: 31.6 kW
	1.5:1 VSWR	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 31.4 kW
	(CHANNEL 2)				
	1.1:1 Load	Po:	25.5	---	Po: 31.4 kW
	1.5:1 VSWR Mismatch	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 31.4 kW
	(CHANNEL 3)				
	1.1:1 Load	Po:	25.5	---	Po: 31.1 kW
	1.5:1 VSWR Mismatch	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 30.6 kW

Section 6.0 Post Random Vibration Tests: (Section 5.2)

TEST	TEST CONDITION		SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE
Output Load	Pulse Test Condition, A				
	(CHANNEL 4)				
	1.1:1 Load	Po:	25.5	---	Po: 30.6 kW
	1.5:1 VSWR Mismatch	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 30.0 kW
	(CHANNEL 5)				
	1.1:1 Load	Po:	25.5	---	Po: 29.4 kW
	1.5:1 VSWR Mismatch	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 29.4 kW
	(CHANNEL 6)				
	1.1:1 Load	Po:	25.5	---	Po: 28.1 kW
	1.5:1 VSWR Mismatch	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 27.8 kW

Section 6.0 Post Random Vibration Tests: (Section 5.2)

TEST	TEST CONDITION		SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE 1	TUBE PERFORMANCE 2
RF Frequency & Bandwidth & Channel Select Time (Ref Para 4.5 & 4.7)	(CHANNEL 1) Frequency = Fo -500 MHz	Po:	25.5	---	Po= 29.2	30.3 kW
		-3 dB BW:	20	45	BW= 26	29 MHz
	(CHANNEL 2) Frequency = Fo -325 MHz	Po:	25.5	---	Po= 29.4	31.4 kW
		-3 dB BW:	20	45	BW= 26	31 MHz
	(CHANNEL 3) Frequency = Fo -150 MHz	Po:	25.5	---	Po= 28.3	31.4 kW
		-3 dB BW:	20	45	BW= 27	30 MHz
	(CHANNEL 4) Frequency = Fo	Po:	25.5	---	Po= 30.0	30.8 kW
		-3 dB BW:	20	45	BW= 27	31 MHz
	(CHANNEL 5) Frequency = Fo +250 MHz	Po:	25.5	---	Po: 28.6	30.2 kW
		-3 dB BW:	20	45	BW= 30	33 MHz
	(CHANNEL 6) Frequency = Fo +500 MHz	Po:	25.5	---	Po= 27.2	28.4 kW
		-3 dB BW:	20	45	BW= 31	34 MHz

Section 6.0 Post Random Vibration Tests: (Section 5.2)

TEST	TEST CONDITION	SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE
Tuning Capability (Ref Para 4.11)	Pulse Test Condition, A Channel Changes	102	---	103

TESTED BY Jerry S Simin DATE 8-25-82

APPROVED BY Kenneth F. Scott DATE 8-31-82

WITNESSED BY Claus Schumacher DATE 8-25-82

APPENDIX D

VKU-7785F S/N B

POST SHOCK TEST REPORT

Section 6.0 Post Operating Shock Tests: (Section 5.3)

TEST	TEST CONDITION		SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE
Static Pressure (Ref Para 4.21)	Collector	150 psi	---	---	No Leaks ok
	Body	150 psi	---	---	No Leaks ok
Body Current & Power Output Pulsed (Ref Para 4.4 & 4.23)	Pulse Test Condition, A	Po:	25.5	---	Po: 26.4 kW
		Iby:	---	850	Iby= 378 ma
	Test Condition Verified ( )				
Output Load (Ref Para 4.9)	Pulse Test Condition, A				
	(CHANNEL 1)				
	1.1:1 Load	Po:	25.5	---	Po: 30.6 kW
	1.5:1 VSWR	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 30.6 kW
	(CHANNEL 2)				
	1.1:1 Load	Po:	25.5	---	Po: 30.2 kW
	1.5:1 VSWR Mismatch	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 30.2 kW
	(CHANNEL 3)				
	1.1:1 Load	Po:	25.5	---	Po: 29.7 kW
	1.5:1 VSWR Mismatch	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 29.7 kW

QUALITY ASSURANCE WORK INSTRUCTION

Title: PERIODIC CONFORMANCE INSPECTION TEST PROCEDURE
VKU-7785 F, S/N B

TEST	TEST CONDITION	SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE
Output Load	Pulse Test Condition, A			
	(CHANNEL 4)			
	1.1:1 Load	Po: 25.5	---	Po: 29.4 kW
	1.5:1 VSWR Mismatch	t: 5	---	t: 5.0 min
	1.1:1 Load	Po: 25.5	---	Po: 29.2 kW
	(CHANNEL 5)			
	1.1:1 Load	Po: 25.5	---	Po: 28.4 kW
	1.5:1 VSWR Mismatch	t: 5	---	t: 5.0 min.
	1.1:1 Load	Po: 25.5	---	Po: 28.2 kW
	(CHANNEL 6)			
	1.1:1 Load	Po: 25.5	---	Po: 27.2 kW
	1.5:1 VSWR Mismatch	t: 5	---	t: 5.0 min.
	1.1:1 Load	Po: 25.5	---	Po: 26.4 kW

Section 6.0 Post Operating Shock Tests: (Section 5.3)

TEST	TEST CONDITION		SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE 1	TUBE PERFORMANCE 2
	(CHANNEL 1)					
RF Frequency & Bandwidth & Channel Select Time (Ref Para 4.5 & 4.7)	Frequency = Fo -500 MHz	Po:	25.5	---	Po= 30.6	30.6 kW
		-3dB BW:	20	45	BW 28	28 MHz
	(CHANNEL 2)					
	Frequency = Fo -325 MHz	Po:	25.5	---	Po= 29.4	30.0 kW
		-3dB BW:	20	45	BW 27	30 MHz
	(CHANNEL 3)					
	Frequency = Fo -150 MHz	Po:	25.5	---	Po= 29.2	29.7 kW
		-3dB BW:	20	45	BW= 27	30 MHz
	(CHANNEL 4)					
	Frequency = Fo	Po:	25.5	---	Po= 29.2	29.2 kW
		-3dB BW:	20	45	BW= 30	29 MHz
	(CHANNEL 5)					
	Frequency = Fo +250 MHz	Po:	25.5	---	Po= 27.5	27.5 kW
		-3dB BW:	20	45	BW= 31	32 MHz
	(CHANNEL 6)					
	Frequency = Fo +500 MHz	Po:	25.5	---	Po= 26.7	26.1 kW
		-3dB BW:	20	45	BW= 32	32 MHz

Section 6.0 Post Operating Shock Tests: (Section 5.3)

TEST	TEST CONDITION	SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE
Tuning Capability (Ref Para 4.11)	Pulse Test Condition, A Channel Changes	102	---	102

TESTED BY [signature] DATE 8-25-82

APPROVED BY [signature] DATE 8-31-82

WITNESSED BY Claus Schumacher DATE 8-25-82

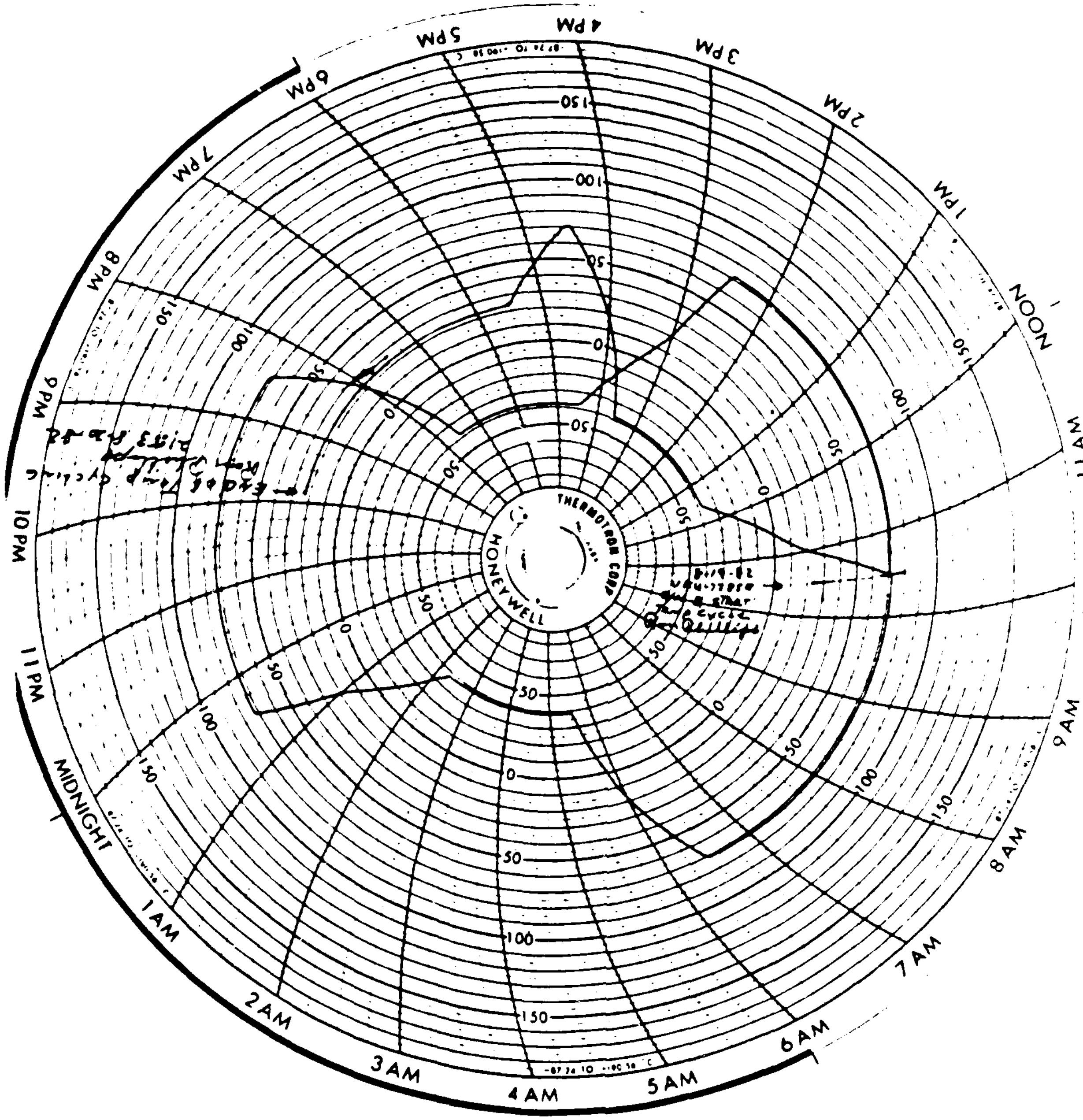
APPENDIX E

VKU-7785F S/N B

TEMPERATURE CYCLING

AND

POST-TEMPERATURE TESTS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1 PM
2 PM
3 PM
4 PM
5 PM
6 PM
7 PM
8 PM
9 PM
10 PM
11 PM
MIDNIGHT
1 AM
2 AM
3 AM
4 AM
5 AM
6 AM
7 AM
8 AM
9 AM
10 AM
11 AM
HONEYWELL
THERMOTRON CORP

Section 6.0 Post Temperature Cycling Tests: (Section 5.1)

TEST	TEST CONDITION		SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE
Static Pressure	Collector	psi:	150	---	No Leaks ok
(Ref Para 4.21)	Body	psi:	150	---	No Leaks ok
Heater Current (Ref Para 4.1)	Ef = 9.0 V rms	If:	---	8.0	If= 7.35 A
Peak Cathode Current (Ref Para 4.2)	Pulse Test Condition, A Drive Power = 0	ik:	---	4.0	ik= 3.37 a
Leakage Current (Ref Para 4.8)	Ef = 9.0 V rms Eb = -26 kVdc Ec = -29.4 kVdc	LIc:	3	---	LIc= .1 mA
Body Current & Power Output Pulsed (Ref Para 4.4 & 4.23)	Pulse Test Condition A	Po:	25.5	---	Po= 28.8 kW
		iby:	---	850	iby= 224 ma

Test Condition Verified (✓)

Title: PERIODIC CONFORMANCE INSPECTION TEST PROCEDURE
VKU-7785 F, S/N B

Section 6.0 Post Temperature Cycling Tests: (Section 5.1)

TEST	TEST CONDITION		SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE
Output Load (Ref Para 4.9)	Pulse Test Condition, A				
	(CHANNEL 1)				
	1.1:1 Load	Po:	25.5	---	Po: 32.8 kW
	1.5:1 VSWR	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 32.2 kW
	(CHANNEL 2)				
	1.1:1 Load	Po:	25.5	---	Po: 32.8 kW
	1.5:1 VSWR Mismatch	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 32.0 kW
	(CHANNEL 3)				
	1.1:1 Load	Po:	25.5	---	Po: 32.5 kW
	1.5:1 VSWR Mismatch	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 31.7 kW

Section 6.0 Post Temperature Cycling Tests: (Section 5.1)

TEST	TEST CONDITION		SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE
Output Load Load	Pulse Test Condition, A				
	(CHANNEL 4)				
	1.1:1 Load	Po:	25.5	---	Po: 31.7 kW
	1.5:1 VSWR Mismatch	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 30.8 kW
	(CHANNEL 5)				
	1.1:1 Load	Po:	25.5	---	Po: 31.7 kW
	1.5:1 VSWR Mismatch	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 30.6 kW
	(CHANNEL 6)				
	1.1:1 Load	Po:	25.5	---	Po: 30.2 kW
	1.5:1 VSWR Mismatch	t:	5	---	t: 5.0 min.
	1.1:1 Load	Po:	25.5	---	Po: 29.8 kW
Hot Insertion Loss (forward) (Ref Para 5.1)		Po:	-47	---	-50 dB

Section 6.0 Post Temperature Cycling Tests: (Section 5.1)

TEST	TEST CONDITION		SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE 1	TUBE PERFORMANCE 2
RF Frequency & Bandwidth & Channel Select Time (Ref Para 4.5 & 4.7)	(CHANNEL 1) Frequency = Fo -500 MHz	Po:	25.5	---	Po= 32.8	33.3 kW
		-3dB BW:	20	45	BW= 29	28 MHz
	(CHANNEL 2) Frequency = Fo -325 MHz	Po:	25.5	---	Po= 32.6	32.[illegible] kW
		-3dB BW:	20	45	BW= 29	28 MHz
	(CHANNEL 3) Frequency = Fo -150 MHz	Po:	25.5	---	Po= 32.5	32.5 kW
		-3dB BW:	20	45	BW= 29	[illegible] MHz
	(CHANNEL 4) Frequency = Fo	Po:	25.5	---	Po= 32.2	31.4 kW
		-3dB BW:	20	45	BW= 30	30 MHz
	(CHANNEL 5) Frequency = Fo +500 MHz	Po:	25.5	---	Po= 31.7	31.[illegible] kW
		-3dB BW:	20	45	BW= 32	32 MHz
	(CHANNEL 6) Frequency = Fo +500 MHz	Po:	25.5	---	Po= 30.6	30.2 kW
		-3dB BW:	20	45	BW= 34	34 MHz
Tuning Capability (Ref Para 4.11)	Pulse Test Condition, A Channel Changes		102	---	102	

QUALITY ASSURANCE WORK INSTRUCTION

Title: PERIODIC CONFORMANCE INSPECTION TEST PROCEDURE
VKU-7785 F, S/N B

Section 6.0 Post Temperature Cycling Tests: (Section 5.1)

TEST	TEST CONDITION		SPECIFICATION MIN.	SPECIFICATION MAX.	TUBE PERFORMANCE
Pulse Duty (RF) Factor	Pulse Test Condition, A	RF Pulse Du:	.03672 max. .03528 min.	---	Du= .036
Beam Duty Factor (Ref Para 4.12)	Pulse Test Condition	Beam Du:	.05610 max. .05390 min.	---	Du= .055
Capacitance (Ref Para 4.13)	Control Electrode to all other electrodes	Cg:	---	100	Cg: 64.6
Motor Transient Current (Ref Para 4.14)	Pulse Test Condition	Current:	---	5.0	.6 A
	(Lock-Unlock Motor) (Tune Motor)	Current:	---	5.0	1.1 A
Motor/Clutch Operating Current (Ref Para 4.15)	(Lock-Unlock Motor)	Current:	---	1.0	0.5 A
	(Tune Motor)	Current:	---	1.0	0.1 A
		Current:	---	0.5	0.3 A

TESTED BY Jerry D. [illegible] DATE 8-21-82

APPROVED BY [illegible] DATE 8-31-82

WITNESSED BY Claus Schumacher DATE 8-21-82

APPENDIX F

VKU-7785F S/N B

CERTIFICATE OF CONFORMANCE

varian/611 hansen way/palo alto/california 94303/u.s.a./415/493-4000

TO: GENERAL DYNAMICS - POMONA, CALIFORNIA

ATTN:

CERTIFICATE OF CONFORMANCE

Buyer's Purchase Order No. P342424

N00123-81-C-245 Mod P 00002

Customer Part No. ______ Spec No. WS18608 Drawing No. 5186595

Varian Part No. VKU-7785F Spec No. 5.288 Drawing No. R092650

Serial Numbers B

Seller certifies that:

1. All final products were tested and inspected to verify compliance with all specified performance and configuration requirements.

2. Records of these tests and inspections are maintained on file for time periods determined by Varian management and are available for review to the extent necessary with the exception of the disclosure of proprietary information.

3. All tests and inspections of final product were performed with equipment calibrated in accordance with MIL-C-45662A with traceability to the National Bureau of Standards.

4. All materials utilized in the fabrication of above products were subjected to tests and inspection to verify compliance with applicable specifications or were accepted based on suitable objective evidence of compliance submitted by supplier.

Signed Finis E. Glendinning

Finis E. Glendinning, Manager
Product Assurance
Palo Alto Microwave Tube Division

F2

END

DATE
FILMED

1 - 84

DTIC